NINTH ANNUAL REPORT

OF THE

OHIO AGRICULTURAL

EXPERIMENT STATION

FOR 1890.

Printed by Order of the State Legislature.

COLUMBUS:
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1891.

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BOARD OF CONTROL AND OFFICERS

OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

SETH H. ELLIS,	Springboro.
HON. JOSEPH H. BRIGHAM,	Delta.
J. L. MCILVAINE,	New Philadelphia.
THE GOVERNOR OF THE STATE,	*Ex-Officio.*
THE DIRECTOR OF THE STATION,	

OFFICERS OF THE BOARD.

SETH H. ELLIS,	President.
PROF. WILLIAM R. LAZENBY,	Secretary.
BERTHA E. WILDMAN,	Treasurer.

STATION STAFF.

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WILLIAM J. GREEN,	Horticulturist and Vice-Director.
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FREDA DETMERS, B. Sc.,	Assistant Botanist.
JOHN A. ALWOOD,	Foreman of the Farm.
EDWIN C. GREEN,	Foreman of the Gardens.
W. H. BAKER,	Meteorologist.

ANNOUNCEMENT.

The Ohio Agricultural Experiment Station is organized under an act of the General Assembly of Ohio, passed April 17, 1882, and supplemented by an act of Congress, approved March 2, 1887.

The Station is prepared to test varieties of grains, fruits and garden vegetables; to examine seeds that are suspected of being unsound or adulterated; to identify and name grasses, weeds and other plants; to investigate and describe the habits of injurious and beneficial insects, and to investigate, and in some cases to suggest measures for the prevention of outbreaks of contagious, parasitic or epizootic diseases of domestic animals.

Any citizen of Ohio, who is concerned in the promotion of agriculture, has the right to apply to the Station for any information it can render, and the Station will cheerfully respond to all such communications, as far as lies in its power.

Address all communications to

EXPERIMENT STATION, Columbus, Ohio.

EXPERIMENT GROUNDS AND OFFICES

ON THE FARM OF THE

OHIO STATE UNIVERSITY, N. HIGH STREET, COLUMBUS, O.

Ninth Annual Report.

REPORT OF THE BOARD OF CONTROL.

To HON. JAMES E. CAMPBELL, *Governor of Ohio:*

SIR: The Board of Control of the Ohio Agricultural Experiment Station submits herewith the annual reports of the Director and other officers for the year ending December 31, 1890.

The work of the Station has gone on without interruption during the past year, no changes being made in the Board of Control or in the working staff. The State appropriation of thirty-two hundred dollars was expended for the purposes for which it was granted, viz.: Six hundred dollars for fitting up the library and museum; one thousand dollars for equipping a chemical laboratory; twelve hundred dollars for the purchase of a steam engine, and for refitting and improving the basement of the barn; two hundred dollars for supplies for the division of Entomology, and two hundred dollars for the expenses of the Board of Control.

After careful consideration, the Board respectfully asks for the following appropriations the coming year: Three hundred dollars for a safe and book-keeper's desk; six hundred dollars for the division of Entomology, to be used in field experiments in the application of insecticides and fungicides in large orchards and vineyards; one thousand dollars for the thorough under-drainage of not less than thirty acres, for field experiments with commercial fertilizers in different sections of the State; one thousand dollars for a tool and farm implement house; five hundred dollars for cases for the museum; five hundred dollars for moving the seed-barn and for painting and general repairs of the Station buildings; five hundred dollars for the illustration of bulletins, and the publication of a bacteriological atlas, and two hundred dollars for the expenses of the Board of Control.

It is earnestly hoped that the appropriations asked for will be granted by the State legislature. The need is imperative, and this small amount of State aid ought not to be withheld.

The rapid growth of the city of Columbus in the direction of the present site of the Experiment Station, and the laying out of new roads,

the construction of sewers, etc., incident to this growth is encroaching upon the State University farm and seriously interfering with reliable field experimentation.

In view of this fact the Board of Control feel justified in considering the subject of the ultimate removal of the Station to a more eligible location. Although this removal may not be necessary for some years to come, it is only a question of time, and the way should be prepared so that the change can be made without loss or any serious break in the lines of investigation now in progress.

The reports of the Director and other members of the Station staff present a detailed summary of the work of the Station for the year. As heretofore, the means and efforts of the Station have been concentrated upon a comparatively few lines of investigation.

The Board of Control believe that the thorough and continuous study of a few of the many important problems demanding solution, with a repetition of experiments from year to year, will result in greater good to the farmers of the State, than a less careful study of many questions where no definite conclusions can be reached.

We especially approve and commend the study and examination of the soils of the State, in order to ascertain their character, their adaptability to various crops, and the effect of various commercial fertilizers upon the same; the experiments with insecticides and fungicides which have given such valuable results; the comprehensive and suggestive variety tests of grains, fruits and vegetables; and the investigation of animal diseases.

In these lines the Ohio Station is fully abreast, if not in advance of all others. The zeal and ability shown by all the officers in carrying out the plans and purposes of the Station have made the labors of the Board a pleasant task. We are also grateful for the kindly co-operation and good will constantly manifested by the Trustees of the State University.

Respectfully submitted.

WILLIAM R. LAZENBY,
Secretary of Board of Control.

REPORT OF THE TREASURER.

HON. S. H. ELLIS, *President Board of Control:*

SIR: The receipts and expenditures of the Station for the fiscal year ending June 30, 1890, are shown below in the following statements:

Statement A being a copy of the report made to the Governor of the State and the Secretary of the National Treasury, as required by the Hatch act.

Statement B showing the income from farm and garden produce and the amount expended from this fund; and statement C being a combination of A and B.

STATEMENT A.

THE OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES TREASURY.

Dr.

1890.		
To receipts from Treasurer of the United States, as per appropriation for year ending June 30, 1890, under act of Congress, approved March 3, 1887		$15,000 00

Cr.

June 30, by	salaries	$8,709 50	
"	labor	3,453 54	
"	supplies	533 87	
"	freight and expressage	62 70	
"	tools, implements, and repairs of same	190 78	
"	fencing and drainage materials	31 98	
"	furniture and general fittings	137 62	
"	technical apparatus	63 73	
"	library	143 41	
"	printing, postage and stationery	884 44	
"	travel, and expenses Board of Control	251 00	
"	incidentals	31 85	
"	buildings	505 58	
Total			$15,000 00

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Ohio Agricultural Experiment Station for the fiscal year ending June 30, 1890; that I have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to have been $15,000.00, and the corresponding disbursements $15,000.00, for all of which proper vouchers are on file, and have been by me examined and found correct.

S. H. ELLIS,
Auditor Board of Control.

I hereby certify that the foregoing statement of account, to which this is attached, is a true copy from the books of account of the institution named.

BERTHA E. WILDMAN,
Treasurer Board of Control.

STATEMENT B.

OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH PRODUCE FUND.

To Receipts.

Dr.

1890.		
June 30, from sales of milk	$2,698 85	
" " " agricultural produce	2,230 15	
" " " horticultural produce	1,269 08	
" from labor	883 35	
Total		$7,081 43
Cash on hand July 1, 1889		209 41
Total		$7,290 84

By Expenditures.

Cr.

1890.		
June 30, for labor	$4,438 89	
" supplies	1,113 04	
" freight and expressage	33 84	
" tools, implements, and repairs of same	106 84	
" live stock	318 65	
" furniture and general fittings	105 15	
" library	31 75	
" printing, postage and stationery	83 10	
" travel, and expenses Board of Control	61 40	
" incidentals	146 75	
" buildings (labor and materials)	338 24	
Total		$6 777 65
Balance carried forward		513 19
Total		$7,290 84

STATEMENT C.

TOTAL RECEIPTS AND EXPENDITURES OF THE OHIO AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING JUNE 30, 1890.

RECEIPTS.

From U. S. Treasury	$15,000 00	
" sales of produce and labor	7,290 84	
Total		$22,290 84

EXPENDITURES.

For salaries	$8,709 50	
" labor	7,892 43	
" supplies	1,646 91	
" freight and expressage	96 54	
" tools, implements, and repairs of same	297 62	
" live stock	318 65	
" fencing and drainage materials	31 98	
" furniture and general fittings	242 77	
" technical apparatus	63 73	
" library	175 16	
" printing, postage and stationery	967 54	
" travel, and expenses Board of Control	312 40	
" incidentals	178 60	
" buildings (materials and labor)	843 82	
Total		$21,777 65
Balance carried forward		513 19
Total		$22,290 84

The sum of $2,000.00 was received from the State Treasurer, under an appropriation made by the Legislature in 1889, for the construction of green-houses and for furnishing them and the office building with heating apparatus. This amount was wholly insufficient for the purpose, and an additional expenditure of $612 22 from other funds was required, making the total expenditure for this purpose as follows:

From State appropriation	$2,000 00	
" national fund	421 58	
" produce fund	190 64	
Total		$2,612 22

This amount was divided as follows:

For green-houses, material and skilled labor	$1,148 49	
" ordinary labor	97 38	
Total		$1,245 87

For heating apparatus, material and skilled labor	$1,334 09	
" " ordinary labor	32 26	
Total		1,366 35
Total expenditure		$2,612 22

The total amount expended for heating apparatus, as given above, includes the cost of heating both the office building and the green-houses, and it is impossible to divide it accurately between the two, as they are both heated from the one plant, having connecting pipes, and much of the work having been done connectedly. It is estimated, however, that about one-third of the total cost should be charged to the green-houses; the remaining two-thirds being estimated as the cost of heating the office building.

In addition to these improvements, a seed-room was constructed in the office building, and some repairs and improvements made about the buildings and farm involving a further outlay of $368.78.

The total expenditure from the three different funds for permanent improvements is shown in the following statement:

STATEMENT D.

TOTAL EXPENDITURE FOR PERMANENT IMPROVEMENTS DURING THE FISCAL YEAR ENDING JUNE 30, 1890.

For buildings, material and skilled labor	$2,714 18	
" " ordinary labor	129 64	
" drainage materials	31 98	
" water and gas fixtures	105 20	
Total		$2,981 00

A further appropriation was made to the Station by the Legislature in 1890; as the expenditures under this appropriation have come within the fiscal years 1890-91, and are not yet concluded, they will be reported in the next annual report of the Station.

Respectfully submitted.

BERTHA E. WILDMAN, *Treasurer.*

REPORT OF THE DIRECTOR.

HON. S. H. ELLIS, *President Board of Control:*

SIR: I have the honor of submitting the ninth annual report of the Ohio Agricultural Experiment Station, for the year 1890.

THE SEASON.

The spring of 1890 was very unfavorable to farming operations throughout the greater portion of Ohio, on account of almost incessant rains. The planting of corn, oats and potatoes was generally delayed, and cultivation was much interfered with until after the middle of June. On the Station farm oats and potatoes were planted late, and both crops suffered so much from blight that not half an average yield was obtained. A part of the corn was planted in fair season, but it grew slowly, and the weather so interfered with cultivation that the crop was materially shortened. Wheat was severely injured by the sudden freeze of March, following a winter of phenomenal mildness, which had stimulated the young plants to constant growth, and had thus kept them in a condition in which they were least able to withstand severe cold. Many varieties were so severely injured that they never fully recovered; others, however, were able, by superior hardiness, to largely overcome the effects of the freeze and to give a fair yield at harvest.

One of the striking peculiarities of the season was the great abundance of smut in wheat, especially of the stinking kind, which in some varieties destroyed from 10 to 30 per cent. of the crop.

Apples and pears were almost a total failure throughout the State. Plums failed at the Station, though yielding abundantly in the lake region. Cherries were less than half a crop at the Station. Grapes and other small fruits gave medium yields.

THE FARM.

The farm belonging to the Ohio State University contains nearly 340 acres of land. That portion occupied by the Experiment Station lies chiefly west of Neil Avenue, and comprises about 205 acres of land, but this includes the main and secondary channels of the Olentangy river, which cover not less than 40 acres. The west bank of the Olen-

tangy is the boundary line of the farm, so that its entire channel, about 16 rods wide by 200 rods long, together with secondary channels of equal area, are included within the farm boundaries. The area actually occupied by the Station does not, therefore, exceed 165 acres. Of this area, about 100 acres is what is known as first bottom, and is subject to overflow. The remainder lies 15 to 30 feet above the bottom plain. The attempt has been made to guard the bottom land from overflow by means of dikes; but these were broken in February last, and the bottom was nearly or entirely covered with water at three different times during the season. It goes without saying that these overflows have very seriously interfered with the Station's work. Some experiments were utterly destroyed, and nearly all of those located in the bottom were so disturbed that we can not place full confidence in the results.

The dikes are still down. It is estimated that to repair them and put them in such condition as to prove an effectual barrier against the river would cost about ten thousand dollars—a sum far beyond the resources of the Station. This sum would be sufficient to purchase outright a farm of 200 acres, located above overflow.

At some time the dikes will be repaired, for the land which they inclose is far too valuable to be abandoned to the river. Its value, however, lies in its adaptation to other purposes than agriculture.

The entire farm lies within the corporate limits of the city of Columbus. The lands adjoining it on all sides are being cut up and sold for building lots, at prices reaching into thousands of dollars per acre. The streets forming the north and south boundaries of the eastern portion of the farm have been paved with asphalt during the past season. In response to a very strong outside pressure, the University Trustees have ordered the opening of Neil avenue through the center of the farm. A great sewer is now being constructed throughout the entire length of the farm, on the portion occupied by the Station, in which work a strip of land five or six rods wide by more than two hundred rods long, running diagonally through the bottom, has been rendered useless for experiment work by the upheaval of the underlying gravel and the trampling of teams in hauling material. Other sewers are to follow, and thus it has become so evident that no one can fail to see that the farm can be used for agriculture but a very few years longer.

But the work of an Experiment Station is work that requires years for its fruition. The great field experiments of Sir John B. Lawes have now been in progress nearly fifty years, but so far is he from regarding them as completed that he has set aside half a million dollars as an endowment for their perpetual continuance. The fact is that the field experiments of a single season have very little value in themselves. It is

only as such tests are multiplied that their results become trustworthy guides to the farmer. Moreover, the most important lines of this work must be continued *year after year on the same soil* in order to have any lasting value. The Rothamsted experiments on soil fertility, already alluded to, would have been worth but little had they been carried on for a few years here, then a few years there, shifting from place to place. It is their permanent character and the persistency with which the same question has been asked of the same soil year after year that has given to them a value beyond all computation.

That Ohio farmers need to-day the help which a similar series of experiments might be to them, none can deny; that the coming generation of Ohio farmers will need this help still more urgently than the present one no one can doubt, who makes himself familiar with the methods of our agriculture. The Experiment Station, therefore, should work for the future as well as for the present. Neglecting to do this it fails to fulfill one of its most sacred obligations.

REMOVAL OF THE STATION.

As has already been stated, the lands occupied by the Station are already far too valuable to be used for agricultural purposes, and they are rapidly increasing in value. At the present rate of growth of the city, it will not be ten years—probably not five—before this value will have increased to such a degree that the University can no longer afford not to open them to settlement. When that time comes the Station must abandon its work here, and seek a location on cheaper lands. But since this removal must inevitably come within so short a period, it would seem to be the part of wisdom to be prepared to profit by the first favorable opportunity that may occur to secure a permanent abiding place.

Moreover, the soil of this farm is not a fair representation of any considerable area of the State, and especially of the soils upon which the need is most urgent of the help which an Experiment Station should give. The natural fertility of the bottom lands of Ohio is well known, and the bottom of the Olentangy, which comprises so large a proportion of the Station lands, is no exception to the general rule, while the fertility of the greater portion of the upland of this farm is almost equal to that of the bottom. For this reason alone, therefore, the Station should be removed and located on a soil more largely representative of the soils of the State.

The great river bottom lands of Ohio have enriched two or three generations of farmers, under the crudest and most wasteful methods of agriculture, and their native fertility is still practically unimpaired. It is upon the upland soils that farming has become a precarious and unprofit-

able business, and it is upon these soils only that the Station can fully accomplish its mission.

THE STATION AND THE UNIVERSITY.

The advantages of having the Station located in proximity to the University have been greatly overestimated. It has been a convenience to the Station to have the use of the lands belonging to the University, and it has been a convenience to the University to have the means of illustration furnished for its classes in agriculture and horticulture, and to have employment furnished to needy students. But the money spent by the Station for permanent improvements upon this farm, since the Station's reorganization under the National law of 1887, would have bought outright a large farm, and one better suited to the Station's work; while the benefit the University has received from the means of illustration afforded by the Station has been insignificant. During the past year two or three young men have made good use of the combined opportunity for study and investigation afforded by the proximity of the two institutions; but the great majority of those who come to the Station for employment come only for the sake of the wages offered, and if it is desirable to conduct the farm simply or chiefly for the benefit of such as these, it can be done far more effectively under a different scheme of management from any that is practicable in an experiment station.

This is said in full sympathy with the working students. It has been my privilege in past years to assist many such students to obtain an education here; I am proud of the fact that so many of them are making an honorable record in the world's work to-day, and I sincerely hope that the facilities for assisting such young men in the future will be greatly extended, and not curtailed. Whether, therefore, the matter be regarded from the standpoint of the Station or from that of the University, it is evident that the time is at hand when the interests of both institutions will be best served by the removal of the Station.

PUBLICATIONS.

In our last annual report was published a joint resolution of the General Assembly of Ohio, providing for the publication of a monthly bulletin of the Experiment Station in an edition of 15,000 copies. Before the end of the year it became apparent that this edition would not be sufficient to meet the demand, and therefore the General Assembly was requested, on re-assembling in 1890, to increase the limit to 30,000 copies. The response to this request was the passage by both houses, and without a dissenting ovice, of the following

JOINT RESOLUTION.

Be it resolved by the General Assembly of the State of Ohio That the bulletins of the Ohio agricultural experiment station shall be printed under direction of the supervisor of public printing, and paid for out of the appropriation for state printing; said bulletins to be printed in advance of other matter, except the crop reports of the state board of agriculture; provided, that the average monthly edition of such bulletins shall not exceed 60,000 copies, that the total number of pages in such bulletins and the annual report of the station shall not exceed 500 in any one year, and that [the annual report only shall] be included in the annual report of the state board of agriculture; and provided, further, that each member of the general assembly shall be entitled to 300 copies of each issue of said bulletins.

It will be seen that this resolution provides for twice as large an edition as that requested by the Station.

The members of the General Assembly have generally manifested a desire to co-operate with the Station in the distribution of the bulletin, and at the end of the year about 31,000 copies were being mailed on the lists of names furnished by them, while the list of independent applications had grown to nearly 17,000, making a total of about 48,000 copies that have been distributed.

Realizing that even through this large edition of the Station, bulletin it was still impossible to reach more than one out of every four or five farmers in the State, arrangements were made early in the year for the publication of a special newspaper bulletin which should give, from time to time, brief summaries of the Station's work and the results obtained, the object being to make these bulletins so brief and comprehensive that the local papers of the State would generally republish them.

By an arrangement with the Central Press Association of this city these bulletins are published almost free of cost to the Station, and they are being reproduced by a large number of the local journals of the State. Their effect, however, seems rather to increase than to diminish the demand for the regular bulletin, applications for which are coming in every mail and in constantly increasing numbers.

THE BULLETIN.

Including the present number, twelve issues of the monthly bulletin of the Station have been published during the year, eleven in the regular and one in the technical series. A brief synopsis of the contents of these bulletins is here given, for the reason explained in my last report, that this number is the only one of the Station's publications that is included in the report of the State Board of Agriculture:

BULLETIN No. 1, JANUARY, 1890, BY W. J. GREEN.

ARTICLE I. *Experiments with potatoes*, including a comparative test of varieties, trial of fertilizers and methods of cutting seed. Following is a summary of the results

Varieties: From the results of eight trials in 1888 and five in 1889, thirteen in all, and made in eleven different localities, the following conclusions may be drawn:

The most productive of the early varieties are Oxford, Puritan Early and Crown Jewel. Next in order stand Nott and Lee Favorite. Of the medium and late sorts Empire State, Summit, Seneca Beauty, White Elephant and Delaware rank the highest of those that are fully tested. Including early, medium and late varieties, not fully tested, those that are the most promising are Queen (New Queen), Rural New Yorker, Superior (Burpee's Superior) and Minnesota Early. Early Ohio, Ohio Junior and Stray Beauty rank as the earliest, but are unproductive. Albino and Chas. Downing seem to be less reliable than formerly, probably owing to susceptibility to blight. Northern Spy and Monroe Prize are inferior in appearance, hence not valuable for market. The former is unproductive, and it is not probable that the latter will rank very high in this respect. Oxford, Seneca Beauty and Delaware show comparatively little variation on different kinds of soil.

Fertilizers: The following conclusions are drawn from results obtained with fertilizers on potatoes, during the entire period that the work has been carried on at the Station. The work has been conducted on several different classes of soil, including tests made in one other section, hence it is believed that fairly representative results have been obtained. It is not possible to secure the same results upon different soils, nor upon any given soil in consecutive seasons, in a trial of fertilizers, but sufficient uniformity is seen in the results to warrant the conclusions given. If the potato grower errs in taking these results as a basis of action, it will be on the conservative side. There is more in the results to teach what not to do than otherwise, but they also give suggestions as to possible use of commercial fertilizers in a profitable manner.

1. Sulphate of potash and muriate of potash have in some instances increased the yield, but in no case sufficiently to make their use profitable.

2. Nitrate of soda and sulphate of ammonia have in a few cases given a slight increase in yield, but not to a profitable degree.

In seasons when blight has been the most severe these substances, especially the former, have apparently exerted an injurious effect.

3. Superphosphate (dissolved bone black), acid phosphate and Thomas slag have in nearly all cases increased the yield. Thomas slag is the cheapest form in which phosphoric acid can be obtained, and the trials indicate that its use on potatoes is likely to be attended with greater profit than that of either of the other substances named.

4. A mixture of sulphate of potash, superphosphate and nitrate of soda has usually given better results than superphosphate alone, but not always.

5. Barnyard manure has increased the yield, but not always the total marketable product, because of the usual prevalence of scab where this fertilizer is used.

6. In no case has the potato crop been benefited, to a profitable degree, by the application of fertilizers, of any kind, on soil that was already in a high state of fertility.

7. On soil that had been worn by previous cropping, phosphatic fertilizers, the so-called complete chemical fertilizers and barnyard manure have in nearly all cases given profitable returns.

8. The rational conclusion is that since the potato requires a soil that is in a high state of fertility, and since the direct application of fertilizers to the crop is attended with considerable uncertainty, the most feasible method is to bring the soil up to the proper condition by enriching the land for previous crops. The best crop of potatoes that has been grown at the Station succeeded a crop of cabbage that had been heavily manured. The most approved practice is to grow potatoes after clover, fertilizing both the clover and preceding crop.

Cutting of seed: 1. Other conditions being the same, the larger the cutting the greater the total product, i. e., the total product varies in about the same ratio as the size of the cutting.

2. The marketable product also increases as the size of the cutting is increased, but does not follow the same ratio as the total product; the rate of gain being less.

3. The increase is found in both the large and small potatoes, the greater portion being in the latter.

4. A crop grown from whole potatoes matures at an earlier date than from small cuttings.

5. Small cuttings require soil that is more highly enriched and thoroughly prepared than large cuttings and whole potatoes, in order to secure a good stand and to produce a profitable crop.

6. The question of relative profit, as between the use of small cuttings and whole potatoes, depends upon the cost of seed potatoes, the date at which the crop is to be harvested and sold, and the condition of the soil at planting time.

7. In ordinary practice it will usually be found that neither extreme, as to quantity of seed used, will be found to be profitable. The safest plan is to use large, well-matured, healthy potatoes, and cut to two and three eyes.

BULLETIN No. 2, FEBRUARY, 1890. BY C. E. THORNE.

ARTICLE II. *Commercial Fertilizers*, including field experiments on corn, oats and wheat; notes on the sources, cost and commercial valuations of commercial fertilizers, and a tabulated statement of analyses of fertilizers sold in Ohio as made by the State Board of Agriculture.

The experiments include seven field tests on corn and five on wheat, made in widely separated parts of the State, and one each on corn, oats and wheat, made at the Station, together with box tests made at the Station, and a summary of the tests of Sir John B. Lawes and the Royal Agricultural Society of England. The conclusions reached are as follows:

Fertilizers on corn: 1. On soils capable of producing fifty bushels of shelled corn per acre with good drainage and tillage, no artificial fertilizer or combination of such fertilizers is likely to produce sufficient increase of crop to pay the cost of the fertilizer in the crop to which it is applied, at present prices of corn and fertilizing materials, respectively.

2. On soils that are decidedly deficient in natural fertility, phosphoric acid may sometimes be used with profit in fertilizing for corn, and potash and nitrogen may be so used in rare instances, and this whether these substances be used separately or in combination.

Fertilizers on oats: Throughout the growing season, the plots that had received nitrogen showed a marked superiority; but these plots lodged badly before harvest, so that most of their advantage was lost.

This result was not unexpected. The problem of securing larger crops of oats is rendered doubly complex by the tendency of this plant to lodge when well fed.

Fertilizers on wheat: These experiments seem to justify the conclusion that in fertilizing for wheat a much greater crop may be produced by using phosphoric acid and nitrogen in approximately equal quantities, the phosphoric acid being applied in the fall, the nitrogen (if used as nitrate) chiefly in the spring, than by the ordinary practice of using phosphates only.

The most important conclusion to be drawn from these tests is, however, that in very many, if not the majority of cases, neither wheat, oats nor corn will return sufficient increase of crop to cover the cost of any artificial fertilizer, at present prices of grain and fertilizers, respectively.

The question whether fertilizers may benefit the crop of grass or clover following wheat sufficiently to justify their use is not touched upon in these experiments.

BULLETIN No. 3, MARCH, 1890. BY J. F. HICKMAN AND H. J. DETMERS.

ARTICLE III. (BY J. F. HICKMAN.) *Experiments with corn*, including 1. Comparative test of varieties; 2. Planting at different depths and on different dates, 3. Distribution of seed; 4. Comparative product of seed from different parts of the ear, 5. Amount of cultivation; 6. Methods of cultivation; 7. Test of varieties of ensilage corn. The conclusions are as follows:

1. Considering the several varieties of corn, according to our present classification, the large yellow dent varieties, as a class, are most productive. Large white dents take second place, followed by medium yellow dents, mixed dents and medium white dents in the order named.

2. In the flint varieties, the large white flints take the lead, followed by mixed flints, and these by yellow flints.

3. Taken as a whole or as individual varieties, the flint corns are not a profitable class for Ohio land, unless it should be in some of the northern sections. The following are noted as failures at the Station: Smut Nose, Top-Over, Hudson Bay, Angel of Midnight, Chadwick, Tuscarora and King Philip.

4. The soft or flour corns have failed to mature in the tests of the last two years. To grow them for stock feeding purposes would not be profitable, and if they are valuable for house use their failure to mature prevents their general adoption in this latitude.

5. Any of the large yellow dent varieties will give fair yields, but the ones more certain of maturing are the Leaming, Murdock's Improved and Woodworth's. The Chester County Mammoth, Cloud's Early Dent and Golden Beauty are quite uncertain; but when they mature they are fine varieties and good producers.

6. Among the medium yellow dents the Clarage and Farmer's Favorite are recommended. Either of these is ten days earlier than any of the large yellow dents, and is probably better adapted to the more northern parts of the State.

7. Of the large white dents, Hess' White is a good variety for gravelly loam soils, or other soils of a gravelly nature. The Champion Early Pearl has done fairly well this year and promises to be a good variety.

8. In seven years' experiments with deep and shallow planting the average results show an advantage in favor of planting one inch rather than two inches deep, but indicate that in dry seasons it may be better to plant two inches deep.

9. The greatest amount of marketable corn has been produced where the stalks averaged 12 inches apart; the variations in yield were slight, whether planted one grain every 12 inches, two every 24, three every 36, or four every 48 inches.

10. Three years' trial has not indicated any marked difference in the reproductive qualities of corn from the butts, middles or tips of the ears. If there is any variation it is in favor of middles and tips and against the butts.

11. The experiments of 1888 and 1889 indicate that corn should be cultivated more frequently in a dry season than in a wet or ordinary one.

12. The average results of two years' experiments favor deep cultivation rather than shallow. The implements used were the harrow and cultivator for shallow tillage and the double shovel for deep.

ARTICLE IV. (BY J. F. HICKMAN.) *Experiments with oats*, including 1 Comparative test of varieties, and 2. Distribution of seed. Following is a summary of the results:

1. In the comparative test the varieties giving the highest yield in 1889 were the Improved American, Monarch, Rust Proof, Welch and Colonel. Kansas Hybrid, Probsteier and White Schœnen remain among the highest producers.

2. Varieties weighing most to the measured bushel were Centennial, Early Prize Cluster, White Bonanza, Race Horse, White Victoria and Hargett's White.

3. The highest percentage of oats standing at harvest was in the Hopetown, Welch Wideawake, Improved American and Rust Proof.

4. The varieties giving the highest average yield in a series of years are the White Schœnen, Monarch, Probsteier, Early Dakota and Rust Proof. These have averaged 60 bushels and above, some of them for four years, some five and some six.

5. Seeding at the rate of five, six, seven and eight pecks per acre in 1889 gave yields almost identical. Seeding at less than five and more than eight pecks gave smaller yields. In the average of two seasons' experiments a larger yield has been obtained from sowing at the rate of six pecks than from a larger or smaller quantity of seed.

ARTICLE V. (BY H. J. DETMERS.) *Actinomycosis, or Lump Jaw of Cattle and Horses.* Following is an abstract of the article:

Actinomycosis—"Big jaw" or "lump jaw" of cattle, "big head" of horses—is caused by a parasitic fungus, which grows within the bony or fleshy tissues, and is generally found in the jaw, but sometimes in the tongue, in the lungs, and in other parts of the body.

This fungus propagates by "spores," corresponding to the seeds of higher plants, which are widely disseminated, and which find an entrance to the animal through wounds or abrasions of the skin or internal membranes, through the temporary exposures of the tissues in shedding teeth, etc.

When suitably lodged in the animal, these spores produce nests of fungi which may be distinguished by the unaided eye as minute yellowish specks, but which appear under the microscope to be round or oval in shape, and to be distinctly radiated from center to circumference.

The disease produced by this fungus is purely local in its character, affecting only the tissues in which it is immediately situated, and the final emaciation and decline of animals affected with it are due solely to the inability of the affected animal to masticate sufficient food to keep up its condition.

The cure for actinomycosis is either to cut out, or to destroy with caustics the disease-producing fungus. If the diseased growth has penetrated the bones, or is so located that neither of these methods can be employed without interfering with important blood vessels or other organs, no cure can be effected; but if it be a simple sarcomatous (fleshy) tumor, and so situated that the surgeon's knife may be safely used, a cure may be effected by the complete removal of the tumor, followed by antiseptic treatment. In many cases where it is not practicable to use the knife, the diseased growth may be removed by the thorough use of caustics, minute directions for which are given.

BULLETIN NO. 4, APRIL, 1890. BY C. M. WEED.

ARTICLE VI. *Spraying to prevent insect injury,* containing illustrated desciptions of spraying machines; formulæ for the use of insecticides in spray; the crops to spray, and brief hints on the philosophy of spraying.

ARTICLE VII. *The Bark-lice of the Apple and Pear.* Descriptions of the oyster shell bark louse and the scurfy bark-louse, with remedies, viz.: Scraping the trunk and larger branches during the winter, and then scrubbing with a mixture of one part crude carbolic acid to seven parts of a solution made by dissolving one quart of soft soap or one-eighth pound of hard soap in two quarts of boiling water.

ARTICLE VIII. *The Buffalo Tree-hopper.* Illustrative descriptions with suggestive remedies.

ARTICLE IX. *Insects Affecting Corn in Southern Ohio.* Illustrated description of the white grub, the twelve-spotted cucumber beetle, and the corn-root louse. Rotation of crops with high fertilization is suggested as the remedy for the first, and rotation for the second. No remedy has yet been discovered for the third.

ARTICLE X. *The Ox Warble Fly, or Bot Fly.* Illustrative description, with recommendation that the grubs be squeezed out of the cattle's backs during the early spring and destroyed.

ARTICLE XI. *Fungous Diseases of Plants and their Remedies.* Notes on potato blight, apple scab, pear leaf blight, powdery mildew of apple and cherry, and plum fruit rot, with suggestions for treatment.

ARTICLE XII. (BY FREDA DETMERS.) *Directions for Collecting, Preserving and Studying Plants.* Illustrated.

BULLETIN NO. 5, JUNE, 1890. BY C. E. THORNE AND J. F. HICKMAN.

ARTICLE XIII. *Corn Silage vs. Sugar Beets as Food for Milk Production.* This article includes the details of a comparative feeding experiment made this year with twelve cows, and compares the results attained with those of two previous experiments, one made in 1889 (described in this report for last year) and one made in 1879 (described in the report of the State Board of Agriculture for that year, page 473). The following conclusions are reached:

In all these experiments the beets have directly or indirectly increased the flow of milk, but the increase of milk alone has not in any case been sufficient to pay the extra cost of the rations of which the beets formed a part, with milk rated at its ordinary value on the farm.

Taking the experiment of this year alone, the increase of live weight apparently due to the beets, added to the increase of milk, would amply justify the increased cost of feed; but in last year's experiment the increase of live weight was greatest with the silage; hence we are in doubt whether the difference this year may not be due to an inferior quality of silage, notwithstanding the fact that the silage this year was eaten clean by every cow but one, whereas last year every cow refused more or less of her silage ration. The ration given last year was larger than that of this year however, and the amount actually consumed was larger, 40 pounds being fed and about 36 pounds eaten, whereas this year but 27 pounds were fed, all of which was eaten. This year's silage was made from corn that was not so ripe and that contained a smaller proportion of grain than that of last year. Being less mature, the butts of the stalks were not so hard as in the silage of last year, and these formed the principal portion of the residue not eaten in the experiment of that year.

In the experiment of this year beets and corn silage were fed in equal quantities of dry matter. Had the dry matter of the beets cost no more to produce than that of the silage, pound for pound, without regard to digestibility, then the increased consumption of hay caused by the beets would have been covered by the increased production of milk, without regard to live weight, and approximately the same result would follow a similar valuation of the beets in the experiments of 1889 and 1879. But the actual dry matter of beets costs considerably more to produce than that of corn silage, being only comparable in cost with the digestible dry matter of the silage. We must therefore find that the increase in live weight, apparently due to the beets in this year's experiment, is in reality so due, and not merely accidental, before we can safely compare beets and corn silage on the basis of their digestible dry matter.

A comparison of the results of feeding corn silage this year and last, indicates that there may be wide differences in the values of such silage, due to the method of culture and state of maturity when harvested, and that such differences may not be revealed by the apparent relish with which the silage is eaten.

The same article contains a comparison of corn silage and dry-cured corn fodder, compiled from the work of other Stations, from which the conclusion is reached that there is practically no difference between the feeding values of a given quantity of corn cured as ensilage and an equivalent quantity cured as dry fodder, provided equally good husbandry has been practiced in both cases.

Rotten silage and weather beaten corn fodder may be compared with each other, but not with well cured materials.

Whether corn may be cured and preserved more economically by the one process or the other depends largely upon local circumstances and seasonal peculiarities.

BULLETIN No. 6, JULY, 1890. BY J. F. HICKMAN.

ARTICLE XIV. *Experiments in Wheat Seeding*, embracing 1. Thick and thin seeding; 2. Early and late seeding, and 3. Seeding at different depths and by different methods. Following is the summary of results:

Quantity of Seed per Acre. 1. Changing the variety of wheat used in the thick and thin seeding experiment does not indicate that former conclusions were wrong, but the duplication in this test with another year's experiment confirms the work of previous years in showing that five pecks of good clean seed will yield almost as much per acre as seven, while more than seven and less than five have produced fewer bushels per acre.

2. In general, as the seed per acre is increased, the total yield of straw is augmented. Exceptional years do not warrant this conclusion, but the average of a series of years shows this to be generally true.

Time of Seeding. 1. After seven years' trial we have found that, with a single slight exception, the highest yields have been produced from seeding during the last week in September and the first week in October.

2. For 1890 the product from the land seeded November 1st, was almost as high as where the seeding was a month earlier. This was probably due to the unusually open winter of 1889–90.

Depth of Seeding. 1. Seeding from one and one-half to two inches deep will, in most soils, give better results than deeper or more shallow drilling.

2. Five years' experiments with the roller or wheel following in the track of each drill hoe indicates that the practice may be a good one; at least it is worthy of a more thorough test.

ARTICLE XV. *Comparative Test of Varieties of Wheat.* A comparative test of about 70 varieties in 1890, with comparisons of part of the number over a period of six to ten years. Following is the summary:

Varieties. The Valley, Nigger, Penquite's Velvet and Diehl Mediterranean are among the leading red-bearded wheats; of the smooth red wheats, the Red Fultz, Poole and Finley (Fultz); of white wheats, Silver Chaff (smooth), Royal Australian (Clawson), Martin's Amber and Democrat.

White or Red Wheats. The difference of but seven-tenths of a bushel in the average yield of 95 trials of white wheat, extending over a series of ten years, and of 313 trials of red wheat, during the same years should settle pretty conclusively that the one is about as hardy and reliable as the other.

Bearded vs. Smooth Wheats. The average yield of 162 trials of bearded wheat and of 234 trials of smooth wheat, extending over a period of ten years, shows but six-tenths of a bushel difference in the average total yield, which suggests that the one is equal to the other in point of vitality.

Varieties for Black Soil. A test in which twelve varieties were grown on black land, indicated a marked superiority for Penquite's Velvet.

ARTICLE XVI. *Smut in Wheat.* A description of the parasite, record of its effects on the different varieties grown at the Station, and suggestions for prevention.

BULLETIN No. 7, AUGUST 1890. BY W. J. GREEN.

ARTICLE XVII. *Strawberries.* Comparison of varieties. Following are the conclusions:

1. To meet the wants of strawberrry growers a variety ought to have sufficient

health and vigor to adapt itself to widely varying conditions, and to possess one or more marked characteristics. It is not worth while to seek varieties that are adapted to particular soils, since varieiies that have a limited range are generally found to be variable and untrustworthy. The most valuable varieties are the least variable, and are easily suited as to soil and climate.

2. The following varieties have been thoroughly tested and are suited to the wants of those who grow berries for market: Bubach, Eureka, Haverland, Crescent, Warfield.

3. Where large berries are desired rather than quantity, the following can be recommended for home use or for market: Cumberland, Crawford, Gandy, Louise, Lida, Miami, Pearl.

4. The new varieties that seem to be most promising are Enhance, Farnsworth, Ivanhoe, Middlefield, Muskingum, Michel's Early, Parker Earle, Shuster's Gem, Waldron.

5. Those that have good points, but are doubtful and need further testing are Cloud, Lady Rusk, Stayman's No. 1. Daisy.

6. The following will no doubt be dropped soon: Hoffman, Jessie, Logan, Pineapple.

7. The most productive varieties are those that have a long season, i. e., give a comparatively large number of pickings.

8. Very early, and extremely late varieties, are less fruitful than the medium early.

9. Perfect flowered, as a rule, are less productive than the pistilate, or imperfect flowered varieties.

ARTICLE XVIII. *Raspberries.* A variety test, including notes on some of the newer varieties. Summary:

1. The black cap varieties that are now considered the most reliable are as follows: Gregg, Hilborn, Ohio. Palmer.

2. The red sorts that succeed best generally are Turner and Shaffer; the best for shipping are Brandywine and Marlboro.

3. Muskingum, Royal Church and Thompson's Early Prolific are the most promising of the newer varieties.

BULLETIN No. 8, SEPTEMBER, 1890. BY C. M. WEED.

ARTICLE XIX. *Plum Curculio Experiments.* The results of a series of experiments made on a large scale in orchards in Ottawa county, in which the jarring method was contrasted with spraying with Paris green, indicate that spraying is as effective a preventive of the curculio as jarring, and far cheaper.

ARTICLE XX. *Experiments with remedies for the Striped Cucumber beetle.* The results agree with those of a similar series of experiments, made in 1889, in indicating that covering the young plants with muslin or wire cloth to exclude the egg-laying beetles is one of the most efficient preventives. In the experiments of this year, very satisfactory results followed the use of tobacco powder, applied in liberal quantity to the hills.

ARTICLE XXI. *The Rhubarb Curculio.* Investigations at this Station on the life-history of this insect have led to the discovery that in this section it usually passes the winter in the adult state, and comes forth in the spring to deposit its eggs in certain species of dock. The remedy, therefore, is to destroy the docks.

ARTICLE XXII. *On the life-history of the Clover-stem Borer,* including a list of the different plants in which this insect has been found.

ARTICLE XXIII. *A second experiment in preventing the injuries of potato blight.* The results agree with those of 1889 in indicating that this disease may be controlled with Bordeaux mixture, but further investigation is necessary.

BULLETIN No. 9, OCTOBER, 1890. BY W. J. GREEN.

ARTICLE XXIV. *Asparagus.* Including a comparison of the yield of seed-bearing and non-seed-bearing plants, which shows that the latter are much the more productive, and notes on the use of rubber bands in bunching asparagus.

ARTICLE XXV. *Transplanting Onions,* being the report of an extensive series of experiments in growing onion plants in March in the cold frame or green-house and transplanting early in the spring. The results were as follows:

1. Transplanting increased the yield one hundred per cent. in some cases, and gave a decided gain with all varieties. The varieties that gave the best results were Pompeii, Prize-taker and White Victoria. Those showing the smallest gain were Danvers, Wethersfield and Michigan.

2. The transplanted onions were larger and more uniform in size, than those grown from seed in the ordinary manner.

3. The transplanted onions ripened from three to four weeks earlier than those grown from seed sown in the open ground.

4. The extra labor involved in transplanting was offset by the saving of labor in weeding. The increase in crop, without a corresponding increase in labor, lessened the cost per bushel in production.

BULLETIN No. 10, NOVEMBER, 1890. BY C. M. WEED.

ARTICLE XXVI. *Experiments in preventing downy mildew, or brown rot of grapes.* Giving life history of fungus causing the disease and reports of experiments made in co-operation with the Station on the islands of Lake Erie with various fungicides, which show that *eau celeste* is a complete and practical preventive of this disease.

ARTICLE XXVII. *The smut of Indian corn.* An article by C. E. Bessey, of the Nebraska Experiment Station, reprinted by permission in response to numerous inquiries for remedy for this disease.

In addition to the foregoing issues of the regular series, a second number of the technical series of the Station's bulletins has been published containing three articles, viz.:

ARTICLE IV. *A catalogue of the uncultivated flowering plants growing on the Ohio State University Grounds,* by Moses Craig, B. Sc.

ARTICLE V. *Fourth contribution to a knowledge of the life history of certain little known plant lice,* by C. M. Weed, D. Sc., containing technical descriptions, illustrated by plates, of the Cherry plant louse (*Myzus cerasi, Linn.*); the Willow Grove plant louse (*Melanoxanthus salicti, Harris*); the Spotted Willow plant louse (*Melanoxanthus salicis, Linn.*), and the White pine plant louse (*Lachnus strobi, Fitch*).

ARTICLE VI. *A descriptive Catalogue of the Shells of Franklin County, Ohio. Part I., Land Shells,* by H. A. Surface.

BIOLOGICAL AND SOIL SURVEY OF THE STATE.

Articles IV and VI of this bulletin are designed as contributions to a biological survey of the State, one object of such a survey being to obtain a better knowledge of the inter-relationship of the flora and fauna of the State, a knowledge which is indispensable to a thorough mastery of the problems which beset the student of Economic Entomology.

This point is illustrated by the fact mentioned on a previous page, that the rhubarb curculio spends part of its life in the wild docks; other illustrations are found in the many instances in which injurious insects are more or less completely held in check by parasitic or predaceous insects, by fungous diseases, or by birds, and in the fact that some of the shell-bearing mollusca serve as hosts to certain parasites which become injurious to animals or vegetation in other stages of their existence.

Perhaps no form of the life of field or forest is regarded with less interest by farmers in general than the snail; yet certain species of snails, especially certain European species which have lately been introduced into this country, are very destructive to some cultivated crops; other species serve as the means of propagating one of the most fatal diseases of sheep—the liver rot; and the presence or absence of snails guides the vine grower in certain districts in selecting the soil for his vineyard. With these facts in view, the study of this humble citizen of the animal kingdom can not be condemned as having no relation to agriculture.

A second object of a biological survey is to obtain a better knowledge of the soils of the State through the study of their vegetable and animal life. The fact is well understood by farmers that the native vegetation of a region is an excellent index to the character of its soil; but, as already indicated, the animal life of the soil is not without significance in this respect.

The splendid Geological Survey of Ohio has given us an exhaustive knowledge of the mineral resources of the State; but the value of the annual product of Ohio's fields and orchards is not less than double that of the combined product of all her mines of iron and coal, her quarries of stone and her wells of oil and gas. The supply of iron and coal and of oil and gas will some day be exhausted; but in the soil of Ohio lies potential food for millions of people throughout ages of time, and no economic problem is of greater importance to the people of Ohio to-day than that of extracting this food with the least present cost and the least waste of future resources.

The volumes of the Geological Survey contain much valuable information concerning the soils of the State—enough to demonstrate the value of a thorough soil survey in which the geological origin, the present composition, the drainage and exposure and the native fauna and flora of the various soils should be as systematically studied as the underlying rocks have been.

To carry such a survey to successful issue would require the combined labors of the Geologist, Chemist, Botanist, Zoologist and practical Agriculturist; but the result of such a survey, properly directed, would be less

valuable than those of the Geological Survey only because the Geological Survey must form the basis of the soil survey.

Such a survey as that indicated is entirely beyond the present resources of the Station; but it seems well to preserve the fragments of the material upon which it will ultimately be based which are constantly accumulating as an incidental result of our more strictly economic investigations.

CO-OPERATIVE EXPERIMENTS.

Attention is called to the experiments in spraying for the prevention of the plum curculio and the grape rot, made in the great fruit region on and near the islands of Lake Erie, and described in the accompanying report of the Enthomologist and Botanist.

It is believed that no other method of dealing with these problems, so important to the fruit industry of the State, can compare in efficiency and in value of results with that of going into the centres of fruit production and there carrying on experiments on such a scale as the commercial fruit-grower would adopt.

The experiments thus far made have been of the nature of a preliminary survey only, but they have thoroughly demonstrated the practicability of the method, and it is earnestly hoped that the Station may receive the means for continuing the work another season on a scale sufficiently extensive to definitely settle the questions involved.

FIELD-TESTS OF FERTILIZERS.

In this connection, attention is called to another, but similar line of work in which the Station has been engaged, and which it is believed should now be put upon a more effective basis, namely: the field testing of commercial and other manures on representative soils of the State.

No argument is required to support the statement that the results of fertilizer tests, made on the fertile soil of the Station farm, can not safely be taken as a guide by farmers whose soil is of a very different character; neither is it necessary to insist that this question of maintenance of soil fertility is one of the most important of the problems that confront the Ohio farmer to-day.

This problem has now been under investigation at this Station over a period of nine years, and during the past two seasons we have had the coöperation of a number of intelligent farmers in various parts of the State. The principal outcome of all this work is the conviction that no trustworthy results are to be hoped for from desultory experiments, made on undrained or irregularly drained soils.

By careful selection of soil, by thorough artificial drainage, and by

the exercise of the utmost care in the cultivation and harvesting of the crop, the Station has at last succeeded in securing consistent results. It is believed that the same preparation of the soil and care in the management of its crops would secure similar results elsewhere, and that three or four field stations for the study of this problem, located on as many different classes of soil, would furnish information of incomputable value to the farmers of the State.

FARMERS' INSTITUTES.

I have again the pleasure of acknowledging the obligation of the Station to Mr. L. N. Bonham, Secretary of the State Board of Agriculture, for the opportunities the members of the Station Staff have enjoyed of meeting the farmers of the State in their county institutes. Not only do these institutes offer the most effective medium for that "dissemination of information" required by the organic law of the Station, but they serve a not less important purpose in bringing the Station workers into direct contact with the most intelligent farmers, from whom many useful suggestions are constantly being received. About 130 addresses have been delivered during the year by members of the Station Staff, before farmers' institutes, granges, farmers' clubs, and horticultural societies.

ACKNOWLEDGMENTS.

The publishers of the following journals have aided the Station in its work during the year, either by re-publishing abstracts from its bulletins, or by donating their publications to its library:

OHIO AGRICULTURAL JOURNALS.

American Farm and Horticulturist, Lakewood.
American Farm News, Akron.
American Grange Bulletin, Cincinnati.
Farm and Fireside, Springfield.
Farmers' Alliance Herald, Cardington.
Farmers' Home, Dayton.
Gleanings in Bee Culture, Medina.
Journal of the Columbus Horticultural Society.
Miami Horticulturist, Bradford.
Ohio Farmer, Cleveland.
Stuart's Agriculturist and Stock Breeder, Cleveland.

GENERAL PAPERS OF OHIO.

Alexandrian Advance, Alexandria.
Attica Journal, Attica.
Barnesville Republican, Barnesville.
Bryan Press, Bryan.
Buckeye State, New Lisbon.

Burbank Review, Burbank.
Butler County Democrat, Hamilton.
Cambridge Jeffersonian, Cambridge.
Cincinnati Weekly Enquirer, Cincinnati.
Cincinnati Price Current, Cincinnati.
Cincinnati Weekly Times, Cincinnati.
Commercial Gazette, Weekly, Cincinnati.
Cortland Herald, Cortland.
DeGraff Buckeye, DeGraff.
Delaware Democratic Herald, Delaware.
Elmore Independent, Elmore.
Fredericktown Free Press, Fredericktown.
Fremont Journal, Fremont.
Greenville Democrat, Greenville.
Herald, Middleport.
Industrial News, Toledo.
Journal and Messenger, Cincinnati.
Kenton Herald, Kenton.
Leetonia Reporter, Leetonia.
Lodi Review, Lodi.
Monthly Transcript, Lucasville.
Mt. Sterling Trumpet, Mt. Sterling.
Norwalk Chronicle, Norwalk.
Ohio Political Horoscope.
Ohio Press, Steubenville.
Ohio State Journal, Columbus.
Painesville Telegram, Painesville.
Palestine Reveille, E. Palestine.
Plain City Dealer, Plain City.
Press, Columbus.
Public Opinion, Westerville.
Quaker City Independent, Quaker City.
Register, Sherwood.
Republican Reveille.
Saint Paris News, Saint Paris.
Sandusky Democrat, Sandusky.
Shelby News, Shelby.
Times, Rushylvania.
Toledo Blade, Toledo.
Tribune, Chester Hill.
Tuscarawas Advocate, New Philadelphia.
Twin Valley Times, W Alexandria.
Valley Enterprise, Milford.
Venice Graphic.
West Liberty Banner, West Liberty.
Worthington Telegram, Worthington.
Wyandot County Republican, Upper Sandusky.
Zanesville Saturday Night, Zanesville.

PAPERS PUBLISHED OUTSIDE OF OHIO.

Agricultural Epitomist, Indianapolis, Ind.
Agricultural Journal, Montgomery, Ala.
Agricultural Science, La Fayette, Ind.
American Agriculturist, New York City.
American Bee Journal, Chicago, Ill.

American Garden, New York City.
American Meteorological Journal, Ann Arbor, Mich.
American Naturalist, Philadelphia, Pa.
American Rural Home, Rochester, N. Y.
Baltimore Weekly Sun, Baltimore, Md.
Boston Weekly Globe, Boston, Mass.
Botanical Gazette, Crawfordsville, Ind.
Breeders' Gazette, Chicago, Ill.
Bulletin Torrey Botanical Club, New York City.
Canadian Entomologist, Port Hope, Ontario.
Canadian Horticulturist, Toronto and Grimsby, Ont.
Coleman's Rural World, St. Louis, Mo.
Commercial Gazette, Weekly, Pittsburgh, Pa.
Cultivator and Country Gentleman, Albany, N. Y.
Dakota Farmer, Huron, S. D.
Entomologica Americana, Brooklyn, L. I.
Farm and Home, Chicago, Ill.
Farmer and Fruit Grower, Montrose, Col.
Farmers' Advocate, London, Ontario and Winnepeg, Man.
Farm, Field and Stockman, Chicago, Ill.
Farm Implement News, Chicago, Ill.
Farm, Stock and Home, Minneapolis, Minn.
Grange Exponent and Rural and Poultry World, Syracuse, N. Y.
Green's Fruit Grower, Rochester, N. Y.
Holstein-Friesian Register, Brattleboro, Vt.
Horticultural Art Journal, Rochester, N. Y.
Husbandman, Elmira, N. Y.
Journal of Agriculture, St. Louis, Mo.
Maritime Agriculturist, St. John, N. B.
Mark Lane Express, London, Eng.
Mirror and Farmer, Manchester, N. H.
National Stockman and Farmer, Pittsburgh, Pa.
Nature, New York City.
Nautilus, Philadelphia. Pa.
New Dairy, New York City.
Orange Judd Farmer, Chicago, Ill.
Pacific Rural Press, San Francisco, Cal.
Press, The, Weekly, Philadelphia, Pa.
Press, The, Weekly, New York City.
Popular Gardening, Buffalo, N. Y.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago, Ills.
Psyche, Cambridge, Mass.
Rural New Yorker, New York City.
Science, New York City.
Southern Live Stock Journal, Starkville, Miss.
Sugar Beet, Philadelphia, Pa.
Vick's Monthly Magazine, Rochester, N. Y.
Western Farmer and Stockman, Sioux City, Ia.
Western Garden and Poultry Journal, Des Moines, Ia.
Western Resources, Lincoln, Neb.
Western Stockman and Cultivator, Omaha, Neb.
Western Swineherd, Geneseo, Ill.
World, The, Weekly, New York City.

IMPLEMENTS, SEEDS AND PLANTS RECEIVED.

The Agricultural Department of the Station has received the following favors:

J. C. Briggs, Columbus, Ohio, one-quarter ton tobacco refuse.
Brown Manufacturing Co., New York, one Breed's Universal Weeder.
Conklin Automatic Cultivator Co., Wauseon, Ohio, one Automatic Cultivator.
Frank Ford & Son, Ravenna, Ohio, seed corn.
D. A. Ingebretson, Fort Howard, Wisconsin, one peck Norway barley.
A. Monk, Osborn, Ohio, two pecks seed wheat.
W. C. Pinkham, Loveland, Ohio, seed of Butcher corn.
B. B. Queen, Cleveland, Ohio, half barrel rock salt.
J. A. Salzer, La Crosse, Wisconsin, seed corn and mangel-wurzel seed.
W. P. Smith, Bainbridge, Ohio, one peck seed wheat.
F. E. Snyder & Co., Burbank, Ohio, one peck seed wheat.

The Horticultural Department of the Station acknowledges the following contributions:

W. H. Genung & Son, Madison, Ohio, one Iron King seed drill.
C. E. Angell, Oshkosh, Wisconsin, Eureka pea.
F. C. Allen, Williamsfield, Ohio, strawberry plants.
P. E. Bucke, Ottawa, Canada, Northern Light grape.
E. M. Buechley, Greenville, Ohio, blackberry and strawberry plants.
Jacob Bauer, Judsonia, Arkansas, VanDeman strawberry plants.
Wm. Belt, Williamsburg, Ohio, strawberry plants.
Benton Bros, Savannah, Ohio, Barton Seedling strawberry plants.
Will H. Barlow, Barnesville, Ohio, Warren strawberry plants.
Granville Cowing, Muncie, Indiana, Brunette strawberry plants and Andes potato.
M. Crawford, Cuyahoga Falls, Ohio, several varieties of strawberry plants.
Albert Clark, Cambridge, Indiana, Bessie strawberry plants.
H. S. Crow, Little York, Ohio, strawberry plants.
J. T. Derror, Pavonia, Ohio, raspberry plants.
W. W. Farnsworth, Waterville, Ohio, raspberry plants.
Frank Ford & Sons, Ravenna, Ohio, blackberry plants and potato.
Geo. W. Gephart, Mechanicsburg, Ohio, blackberry plants.
A. H. Guisa, Lawrence, Kansas, Kansas raspberry plants.
Stephen Hoyt's Sons, New Canaan, Connecticut, Green Mountain grape.
John Hazleton, Delaware, Ohio, strawberry plants.
J. R. Hawkins, Mountainsville, N. Y., Banquet strawberry plants.
W. A. Huntsman, Lawson, Missouri, Huntsman strawberry plants.
J. C. Kester, New Carlisle, Ohio, raspberry plants.
J. T. Lovett Co., Little Silver, New Jersey, Lovett's Early strawberry; Jewett blackberry and Lovett raspberry.
Geo. W. Lee, Jr., Homeworth, Ohio, Stella strawberry plants.
A. A. Minus, Bellevue, Ohio, Minus' strawberry plants.
E. E. Merry, Hartford, Ohio, potatoes.
W. H. Phillips, Staunton, Indiana, strawberry plants.
J. S. Pumphrey, Celina, Ohio, raspberry plants.
E. A. Riehl, Alton, Illinois, strawberry and blackberry plants.
E. L. Roser, Brittan, Ohio, strawberry plants.
E. W. Reid, Bridgeport, Ohio, several varieties of strawberry plants.
John A. Salzer, La Crosse, Wisconsin, Governor Rusk potato.
I. F. Street, West Middleton, Indiana, strawberry plants.
M. T. Thompson, Lakewood, Ohio, strawberry and raspberry plants.

J. Van Lindley, Pomona, N. C., Westbrook strawberry plants.
Virgil Wilson, Huntsville, Alabama, blackberry plants.

We find the "Breed's Universal Weeder" a useful implement to use in young corn or similar crops, under the same conditions in which the smoothing harrow may be effectively used.

The "Automatic Cultivator" has been used throughout the season and its working has been entirely satisfactory. We hope to see a little improvement in the material used in its construction. With this qualification we recommend it for general use.

The Iron King seed drill has also given entire satisfaction in general garden work. Its shoe, marker and covering attachment are especially valuable features. We believe it to be one of the very best implements of its class.

The seeds and plants will be reported upon in future bulletins.

In conclusion, it is again my pleasant duty to report a year of harmonious work. There has been a conscientious effort on the part of every officer of the Station to forward the cause in which we are all working, and this effort has been appreciated by the Board of Control.

Respectfully submitted.

CHARLES E. THORNE, *Director.*

REPORT OF THE AGRICULTURIST.

The work of this department for 1890 necessarily followed pretty closely in the same line as in previous years, and may be outlined under three general heads, as follows:

I. Experiments with field crops.
II. The feeding of certain foods produced on the farm, for the purpose of determining their value when compared with standard feeding materials.
III. The comparative cost of producing certain feeding stuffs.

I. The experiments with field crops have included the following lines of work:

Wheat. 1. A comparative test of 60 varieties of wheat.

2. A comparative test of a limited number of varieties on different soils, both at the Station and in different parts of the State.

3. Seeding at different rates per acre, from two pecks up to ten pecks, duplicating the plots by seeding with different varieties.

4. Various methods of seeding, such as deep and shallow planting; rolling before drilling on some plots, and after drilling on others; seeding with the hoe drill and with the shoe drill; broadcasting compared with drilling; mulching.

5. Seeding at various times, from the last of August to the first of November.

6. Comparison of results between small and large plots.

7. Experiments with commercial and other manures on wheat.

Oats. 1. Fifty-four varieties of oats were used in the comparative test, nine of which were new for this locality. A number of these were duplicated, and about ninety varieties were sown in small quantities for the purpose of studying synonyms.

2. The experiment in thick and thin seeding, as conducted in 1889, was repeated.

3. Experiments with commercial and other manures on oats.

Corn. 1. The varieties of corn in the comparative test for 1890 were all of the Dent class, thirty-six in number, several of which were duplicated.

2. All other experiments conducted with corn in 1889 were repeated this year, with the exception of early and late planting.

3. In addition to experiments in the cultivation of corn I have attempted to have a co operative test made by a number of farmers relative to the advisability of cutting or not cutting corn.

Field Beets. 1. More than four acres of land were devoted to the growing of mangels and field beets, the experiments with which were divided into the following divisions:

(a) Comparative test of twenty varieties.
(b.) Continuation of the test on soil exhaustion.
(c.) Culture with and without manure.
(d.) The effects on mangels of transplanting, with and without topping.
(e.) Using mangel and beet tops for siloing.
(f.) Pitting mangel and beet tops the same as the roots themselves.

Reports on the above experiments have been made in part during the year. The experiments in the use of commercial fertilizers on wheat, oats and corn constitute one of the most important branches of the work of this department. The results of these experiments will be published in a future bulletin, in connection with the results of similar work carried on in co-operation with the Station in other portions of the State.

II. Under the second general heading, which pertains to feeding, we have carried on the following work:

1. Investigations on the comparative value of ensilage and sugar beets as milk producers.

2. Determination of the percentage of loss in weight of corn in the silo, by actual weighing of what was put in and what was taken out.

3. Determination by analysis of the variations occurring in percentage of fat and total solids in milk when the cows were fed on different rations.

III. Under the head of comparative cost of feeding stuffs I have carefully kept an account of the actual cost of producing an acre each of mangels and of ensilage corn; the quantity of dry matter in each has been estimated, and the cost of a pound of dry matter in each case calculated.

During the year nearly seven hundred letters of inquiry concerning arm crops, implements and stock, have been answered. The delivering

of thirty-nine addresses during the year before agricultural clubs and farmers' institutes has taken considerable time. Superintending the work of the farm and the dairy, directing permanent and temporary improvements, as well as many other matters pertaining to my department, have, in connection with my office work, made the year one of unremitting toil. I hope it has been spent profitably for the cause of agriculture.

J. FREMONT HICKMAN,
Agriculturist.

REPORT OF THE HORTICULTURIST.

The work in the horticultural department has been along the lines indicated in former reports. The plan has been somewhat modified, by concentrating upon certain lines of work, and giving less attention to others.

The custom of reporting upon long lists of varieties has, for the most part, been abandoned, although it is still necessary to continue planting numerous old and well tried sorts for comparison. The method now proposed for variety work is to confine the tests and comparisons to a few varieties, choosing such as may be necessary to illustrate certain definite and specific points.

More attention has been given during the past year than heretofore to methods of culture and to behavior of varieties under different methods of treatment. As far as possible variety testing has been made incidental rather than objective.

Vegetable novelties have received considerable attention during the year, with a view to the preparation of a special bulletin on the subject, at an early date.

New varieties of small fruits have been given even more attention than vegetables. Some of these have been reported upon in a bulletin issued in August.

Upward of fifty varieties of small fruits have been sent here for trial, during the year by originators. The plan thus far has been to make no public report upon varieties until they have been offered for sale, but it is possible that this plan will be departed from to the extent of illustrating and reporting upon some of the most promising.

Aside from the fruits reported upon, the following fruits, embracing both new and old varieties, have been cultivated, but not all of which have fruited. Apples, a number of varieties top-grafted; pears, trees have been

planted, and top-grafting practiced; cherries, a number of new varieties have been planted; plums, a number of new varieties have been planted; grapes, the leading old and all the new varieties have been planted; currants, gooseberries and blackberries, the lists reported in previous seasons have been retained, and all the new varieties added.

The most important work with vegetables is as follows: Asparagus, comparison of productive capacity of seed-bearing and non-seed-bearing plants, the results of which were published in the October bulletin. Celery, comparison of varieties and development of a plan for growing the crop by farmers and gardeners who do not have soil naturally suited to the purpose. The results are to be published in a future bulletin. Lettuce, comparison of varieties both for green-house and out door cultivation, also methods of culture, and trial of fertilizers. Onions, comparison of varieties, and methods of culture. The results of experiments in transplanting are given in the October bulletin. Peas, a comparison of the various strains of the "extra early" variety offered by different seedmen. Another trial is needed before the results can be reported. Radishes, a trial of varieties in the green-house and comparison of transplanted plants with those grown in place. The results indicate that with the turnip rooted sorts transplanting may be profitably practiced, because of the saving in time of the occupancy of the benches and greater uniformity of the product. Tomatoes, a comparison of the leading early varieties was carried on, but the results require further confirmation before publication. Experiments in forcing tomatoes in the green-house have been carried on with a view to determining the best method.

In the green-houses, which are heated by hot water, the overhead and underneath systems have been compared. The results thus far do not indicate any decided advantage in favor of either method. In the green-house work particular attention is given to the economic aspects in order to determine to what extent the forcing of vegetables is profitable.

In addition to the work of the department now under way, several economic problems in orcharding need immediate attention. The causes of the failure of the apple crop are neglect in cultivation, pruning and fertilization and the increase in fungus diseases and insect enemies. Even in years of abundant crops the quality of the fruit is so far reduced as to render a large share of the crop unmarketable. The causes and remedies are fairly well, but not perfectly understood, and further experiments are required, and more particularly should the practicability of various proposed methods and remedies be investigated. In order to carry forward these investigations it will be necessary to secure the control of an orchard that has come to a bearing age, and one that has a sufficient number of trees of one or more varieties. The pear orchard on the Station

grounds will possibly answer the purpose for pears, but it will be necessary to look elsewhere for an apple orchard.

W. J. GREEN,
Horticulturist.

REPORT OF THE ENTOMOLOGIST AND BOTANIST.

The work of the division of Entomology and Botany during the year may broadly be divided into four general lines, viz.: (1) The investigation of insects and fungi injurious to plants; (2) experiments with methods of preventing the injuries of noxious insects and parasitic fungi; (3) studies on the natural history of Ohio, preliminary to a natural history survey of the State; and (4) the dissemination of information upon these topics among the farming community.

The work of the year coming under the first of these headings—that of original investigations—has included quite a number of important practical subjects. Of these I may mention the following:

(1.) Investigations on the life history of the Rhubarb Curculio (*Lixus concavus*), an insect that is attracting considerable attention in gardens.

(2.) Important discoveries concerning the breeding habits and parasites of the Clover Stem Borer (*Languria mozardi.*)

(3.) The discovery of the hitherto unknown sexual generation and eggs of the Cabbage Aphis (*Aphis brassicæ*), and of the winter history of nearly a dozen other species of injurious plant lice.

(4.) Observations on the life histories and habits of a number of insects boring the stems of various plants.

(5.) Investigations of the causes of Potato Blight.

(6.) Blight studies of a serious injury to wheat, hitherto unrecorded in this country due to a fungus known to botanists as (*Fusisporium culmorum*), the disease being commonly called "Wheat Scab" or "White Head."

(7.) Studies of the Mildew affecting lettuce.

(8.) Studies, by Miss Detmers, of the rusts and mildews of the State.

Under the head of experiments, proper, I have to report a considerable number of tests of remedies for injurious insects and fungous diseases, some of which have yielded very satisfactory results. They may be summarized as follows:

(1.) A commercial test of spraying with the arsenites as a preventive of the injuries of the Plum Curculio.

2.) Field tests of a number of remedies for the Striped Cucumber Beetle.

3.) Tests of the comparative injury to foliage by London purple and Paris green.

(4.) Experiments to determine the effect on foliage of various combinations of insecticides and fungicides.

(5.) Experiments with remedies for plant-lice.

(6.) Field experiments with certain copper compounds as remedies for the Downy Mildew and Brown Rot of grapes.

(7.) Field tests of certain copper compounds as preventives of Potato Blight.

The work on the natural history of Ohio has covered a wide field and has been carried on during the intervals between studies of more immediately practical importance. It has embraced studies and collections of the birds, shells, batrachians, reptiles, insects, flowering plants and fungi of the State.

The dissemination of useful information, either the result of our own investigations and experiments, or of others has formed an important feature of the work of the division during the year. The results in this line may be summarized as follows:

(1.) Replying to about six hundred letters of inquiry concerning injurious and beneficial insects, fungous diseases, and plants of various kinds.

(2.) The publication of nineteen articles, aggregating 200 pages in the Station Bulletin, and the preparation of eleven newspapers bulletins.

(3.) The publication of about 100 articles in the leading agricultural and horticultural journals.

(4) The delivering of forty addresses before farmers' institutes and horticultural societies.

During the year we have added very largely to the collections of the division, as will be seen from the following summary:

(1.) About 8,000 specimens of plants have been collected and preserved.

(2.) About 6,000 insects have been added to our miscellaneous collections.

(3.) Two hundred bird skins have been collected and preserved.

(4.) About 3,000 Ohio shells have been added to our collections in this group.

During August I attended the meeting of the American Association for the Advancement of Science, reading papers before the Biological Section, the Entomological Club and the Botanical Club; and also the meeting of the Society for the Promotion of Agricultural Science before which I read two papers. During November I attended the meeting of the Association of American Agricultural Colleges and Experiment Stations, and presented three papers before the Entomological Section.

I have been indebted to the efficient assistance of Miss Freda Detmers for the preparation of a large number of drawings of plants and insects, many of which have already been published, and others are yet to be engraved. Miss Detmers has also devoted much of her time to the study of parasitic fungi, both as to their classification and development, and has

in preparation a descriptive catalogue of the Ohio forms of two of the more important families. I have also to thank Messrs. J. S. Hine and E. V. Wilcox for the zeal and fidelity with which they have performed certain lines of work intrusted to their care during part of the year.

CLARENCE M. WEED,
Entomologist and Botanist.

REPORT OF THE VETERINARIAN.

Ever since I began in 1878 my investigation of swine-plague, or so-called hog-cholera, it has been my endeavor to obtain practical results—results that would enable every intelligent farmer to prevent or to check that disastrous disease. Of course, first the true cause of the morbid process and its spreading had to be ascertained.

In this I succeeded quite early. Already in the fall of 1878 I was able to demonstrate, not only that swine-plague is an infectious and bacteritic disease, but also that it is caused by a certain short, rod-shaped, slightly motile bacterium, from 0.4 to 0.6 μ. in thickness, and from 0 8 to 3 μ, in length, which I called Bacillus suis. I also ascertained the fact that an attack from which the animal recovers, produces, if not positive, at least relative immunity or protection against subsequent attacks. It is true, and I stated it in my reports, I already then observed some cases, in which one and the same animal had a second attack, and at least one case, in which a pig had three attacks of undoubtedly genuine swine-plague. But in all these cases the second attack was not fatal, and in most of them even milder than the first. The animal, which had three attacks, also recovered. Its third attack was the mildest.

These cases, just mentioned, however, were comparatively few in number, and only exceptions, because in a vast majority of those cases, in which a recovery from the first attack took place, the animals, after recovery, possessed perfect immunity; at least, did not react upon an inoculation with the most potent or malignant material, and did not contract the disease, if ever so much exposed to a natural infection.

Want of means and other work prevented a continuation of my researches, until I became connected with the Ohio Agricultural Experiment Station at Columbus, when the same were taken up again. But having also to teach my classes as Professor in the Ohio State University, and, at the same time, having but very limited means at my disposal, my researches could not be pursued with as much vigor as I desired. Indeed,

they often had to suffer from interruptions. Frequently at the very moment, when it was most needed, either suitable material or suitable animals to experiment upon, were not available. Thus it became difficult, or at least, it took a good deal of time to obtain definite results.

During the past year, however, results, which I must consider definite and conclusive, have been obtained in so far, that I have succeeded in finding a substance, which, if subcutaneously inoculated, will produce immunity, or, at least so far, has prevented an infection, and afforded perfect protection, no matter whether the animals were inoculated with potent material, or exposed in any conceivable way to a natural infection.

Until recently the effect of the protective inoculation could be tested only on a few experimental animals—I had only two pigs at my disposal—, but within the last month or two, an opportunity was offered through the kindness of Mr. O. Harbage at West Jefferson, Madison Co., O., to test it on a larger scale. This testing will be continued for some time wherever an opportunity is offered. If the protective inoculation proves in every case to be effective in producing immunity against a natural infection, as I have no doubt it will, the material used will be prepared in sufficient quantities and be given at cost-price, and with proper instructions how to use it, to a sufficient number of responsible veterinarians, if they apply for it and agree to certain conditions, necessary as a safe-guard against quackery and overcharging.

To exclude any misunderstanding, I will here state that neither I nor the Ohio Agricultural Experiment Station, intend to make any money out of it; but that I desire to retain the preparation of the material under my control, at least for some time, simply to prevent unscrupulous and irresponsible persons from imposing upon and defrauding the farmer. It will probably be yet a couple of months until the experiments, made at present on a larger scale, are completed, and until material will be prepared in sufficient quantities to supply outside parties, and then a fuller report in shape of a bulletin may be looked for.

Whether or not my material for protective inoculation is in any way similar or identical to that of Dr. Billings, used by him successfully for a year or more, I do not know, because I am not acquainted with the composition of his material. I do know, however, that the micro-organisms, the bacilli, considered by Dr. Billings and by myself as the cause of morbid process of swine-plague and its propagation are identical.

H. J. DETMERS,
Veterinarian.

REPORT OF THE METEOROLOGIST.

The year has been characterized by the absence of extremes of temperature, high average temperature during January and February, and exceedingly heavy, annual, rainfall.

The high temperatures during December, 1889, and the first two months of 1890 caused the buds of many fruit trees to swell almost to blossoming, and were followed by hard frosts in March which, in consequence, damaged part of the fruit crops quite seriously. The fruits on the Station grounds most damaged by frost were plums, cherries and pears.

The spring work of the farm was much interfered with by heavy rains. There were only a few short periods in April during which even well drained land could be worked, and one period of about ten days during the last of May and the first of June suitable for corn planting. Rainy weather interfered also with the early harvest.

This wet weather was followed, in July and August, by six weeks of very light rainfall, during which growing crops, especially corn, suffered severely on account of drouth.

The abundant rainfall during the latter half of August and the month of September, together with the lateness of killing frosts, in some measure compensated for this loss by making excellent autumn pasturage.

The annual rainfall is far in excess of the average, and a tention is again called to the unfavorable effect upon crops of a slight deficiency of rain during the growing season, even when preceded by the most abundant rainfall.

EXPLANATION OF TABLES.

The following tables contain statistics of temperature, rainfall, etc., for the year, and are compiled from data obtained by daily observations, made at 7 A. M., 2 P. M. and 9 P. M. T stands for "trace," less than 0.01 inch of daily rainfall.

Table I shows the daily rainfall at the Station during the year in inches and hundredths.

Table II shows the daily mean temperature for the same period.

Table III gives a comparison of the temperature, humidity and rainfall at the Station, with the eight-year average for the Station and also with the eight-year average of the State.

Table IV contains the record of atmospheric pressure; the mean temperature; the highest and lowest temperature, with the range of tempera-

ture for each month; the number of clear, fair, cloudy and rainy days; the rainfall and prevailing direction of wind for both the Experiment Station and State.

Table V shows the rainfall at the Station for each month during the last eight years.

Table VI contains the principal points of interest on the temperature, state of weather, and rainfall during the same period, and a grand summary for eight years.

NOTES ON THE WEATHER AT THE STATION.

SUMMARY BY MONTHS.

January.

The mean barometer was 30.204. The highest barometer, 30.762, occurred on the 22d; the lowest, 29.663, on the 12th.

The mean relative humidity was 86.8 per cent.

The mean temperature was 38.8°, which is 13° above the Station average for January. The highest temperature, 68°, occurred on the 13th; the lowest, 8.5°, on the 22d. On 12 days the temperature did not fall to 32°.

Cloudy weather prevailed; rain fell on 18 days, and snow on 4. The total snowfall was 5 inches; the total rain and melted snow, 5.50 inches, which is 1.74 inches above the Station average for this month. The greatest daily rainfall was 1.56 inches on the 15th.

A lunar halo was observed on the 3d.

Fogs occurred on the 25th and 26th.

The prevailing wind was south.

February.

The mean barometer was 30.074. The highest barometer, 30.498, occurred on the 9th; the lowest, 29.488, on the 14th.

The mean relative humidity was 80.7 per cent.

The mean temperature was 39.9°, which is 10° above the Station average for February. The highest temperature, 66°, occurred on the 4th; the lowest, 16°, on the 9th. On 12 days, as in January, was the lowest temperature above 32°.

Cloudy weather prevailed; rain fell on 13 days and traces of snow on 2. The total rain and melted snow was 5.88 inches, which is 2 inches above the Station average for this month. The heaviest rainfall was 1.72 inches, on the 24th, and 1.01 inches on the 25th.

Thunder-storms occurred on the 19th, 24th and 25th.

Lunar halos were observed on the 6th and 26th.

The prevailing wind was northwest.

March.

The mean barometer was 30.096. The highest barometer, 30.566, occurred on the 9th; the lowest, 29.286, on the 27th.

The mean relative humidity was 77.3 per cent.

The mean temperature, 34.3°, is 1.3° *below* the Station average for March. The highest temperature, 63°, occurred on the 21st; the lowest, for March and for the year, 4°, on the 6th. On only 7 days was the lowest temperature above 32°.

Cloudy weather prevailed; rain fell on 15 days and snow on 6; the total snowfall was 3.40 inches; the total rain and melted snow 4.88 inches, which is 1.90 inches above the Station average for March. The heaviest rainfall in 24 hours was 0.98 inches, on the 11th; but during the 4 days, 10th—13th, inclusive, 2.64 inches of rain and melted snow fell.

On the 27th and 28th, at the time of the Louisville tornado, a wind and rain storm, accompanied by thunder, occurred, and about midnight on the 27th the barometer gave the lowest reading of the year, 29.286.

The prevailing wind was northwest.

April.

The mean barometer was 30.106. The highest barometer, 30.521, occurred on the 1st and 2d; the lowest, 29.456, on the 9th.

The mean relative humidity was 71.1 per cent.

The mean temperature, 52.6°, is 3.1° above the Station average for April. The highest temperature, 75° occurred on the 8th and 22d; the lowest, 27°, on the 1st.

Clear weather prevailed; rain fell on 11 days and snow on 1. The total snowfall was 1 inch; the total rain and melted snow, 4.08 inches, which is 1.04 inches above the Station average for April. The heaviest rainfall was 1.62 inches, on the 26th. No rain fell from the 15th to the 22d.

Thunder-storms occurred on the 3d and 9th.

Light frosts occurred on the 2d, 5th, 6th, 20th and 28th; killing frosts on the 1st, 11th and 19th.

Lunar halos were observed on the 2d and 28th; a solar halo on the 22d.

The prevailing wind was northeast.

May.

The mean barometer was 29.940. The highest barometer, 30.317, occurred on the 11th; the lowest, 29.587, on the 5th.

The mean relative humidity was 78.6 per cent.

The mean temperature, 59.3°, is 1.9° *below* the Station average for May. The highest temperature, 86°, occurred on the 30th; the lowest, 32°, on the 2d.

Cloudy weather prevailed; rain fell on 17 days, and the total rainfall was 4.69 inches, which is 0.58 inch *below* the Station average for May. The heaviest rainfall was 1.07 inches, on the 25th. No rain fell on the last 6 days of the month.

Thunder-storms occurred on the 10th, 13th, 18th, 19th, 23d and 24th; hail on the 18th.

Light frosts occurred on the 2d and 12th.

A lunar halo was observed on the 26th.

Fogs occurred on the 5th and 26th.

The prevailing wind was south.

June.

The mean barometer was 29.985. The highest barometer, 30.336, occurred on the 8th; the lowest, 29.757, on the 6th.

The mean relative humidity was 75.2 per cent.

The mean temperature, 73.4°, is 3.9° above the Station average for June, and is our highest record for this month. The highest temperature was 94° on the 29th; the lowest 48°, on the 8th.

Fair weather prevailed; rain fell on 15 days, and the total rainfall was 5.43 inches

This is 1.90 inches above the Station average for June. The heaviest daily rainfall was 1.48 inches, on the 15th, on which date the remarkable rainfall of 1.10 inches in 20 minutes occurred. No rain fell on the first 4 days of the month, and a short period of fair weather occurred from the 18th to the 28th.

Thunder storms occurred on the 5th, 15th, 28th, 29th and 30th, and hail fell on the 15th and 28th.

A lunar halo was observed on the 25th.

The prevailing wind was south.

July.

The mean barometer was 30.005. The highest barometer, 30.247, occurred on the 20th; the lowest, 29.683, on the 2d.

The mean relative humidity was 71.9 per cent.

The mean temperature, 72.9°, is only 0.3° below the Station average for July. The highest temperature, 95°, occurred on the 8th and 15th; the lowest, 45°, on the 21st.

Clear weather prevails; rain fell on 7 days; the total rainfall was 1 41 inches, which is 1.28 inches below the Station average for July. The heaviest rainfall was 0 45 inch, on the 1st. No rain fell on the last 6 days of the month, and only a trace during the period beginning the 14th and ending the 22d.

Thunder storms occurred on the 1st and 24th.

A fog occurred on the 14th.

A brilliant meteor was seen on the 13th.

The prevailing wind was south.

August.

The mean barometer was 30.045. The highest barometer, 30.276, occurred on the 24th; the lowest, 29.714, on the 26th.

The mean relative humidity was 77.3 per cent.

The mean temperature, 68.5°, is 1.1° below the Station average for August. The highest temperature, 94.5°, occurred on the 2d; the lowest, 43°, on the 31st.

Clear weather prevailed; rain fell on 11 days, and the total rainfall was 3.71 inches. This is 0.76 inch above the Station average for August. No rain fell on the first 2 days of the month, so that there was a period of 8 days, embracing the last 6 days of July and the first 2 days of August, on which no rain fell. During the period beginning July 14, and ending August 16, less than 1 inch of rain fell.

Thunder storms occurred on the 1st, 3d, 4th and 17th.

A fog occurred on the 15th.

The prevailing wind was south.

September.

The mean barometer was 30.104. The highest barometer, 30.368, occurred on the 28th; the lowest, 29.872, on the 12th.

The mean relative humidity was 83.4 per cent.

The mean temperature, 61.4°, is 1.8° below the Station average for this month. The highest temperature, 87°, occurred on the 7th and 8th; the lowest, 36°, on the 28th.

Fair weather prevailed; rain fell on 15 days, and the total rainfall was 8.16 inches. This is 4.73 inches above the Station average for this month, and is the greatest monthly rainfall on record at this Station. The heaviest daily rainfall was 2.36 inches, on the 6th. Other heavy rainfalls were, 1.53 inches on the 26th, 1.22 on the 11th, and 0.95 inch on the 10th. During three days from the 4th to the 6th inclusive, 3.12 inches fell

during the period including the 8th and 13th, 2.85 inches fell, and during the ten days including both periods, 5.97 inches.

Thunder storms occurred on the 4th, 5th, 8th and 26th.

Light frosts occurred on the 28th and 29th.

The prevailing wind was south.

October.

The mean barometer was 29.951. The highest barometer, 30.252, occurred on the 9th; the lowest, 29.361, on the 29th.

The mean relative humidity was 83.7 per cent.

The mean temperature, 52.3°, is 3.4° above the Station average for October. The highest temperature was 82°, on the 12th and 13th; the lowest, 31°, on the 30th.

Cloudy weather prevailed; rain fell on 14 days, and a trace of snow on the 29th. The total rainfall was 2.71 inches, which is only 0.19 inch above the Station average for October. The greatest daily rainfall was 0.79 inch, on the 23d.

A light frost occurred on the 15th; a killing frost on the 30th.

Lunar halos were observed on the 27th and 28th.

Fogs occurred on the 3d, 4th, 5th, 10th, 12th and 21st.

The prevailing wind was south.

November.

The mean barometer was 30.096. The highest barometer, 20.367, occurred on the 11th; the lowest, 29.624, on the 17th.

The mean relative humidity was 78 per cent.

The mean temperature, 43.5°, is 3.3° above the station average for November. The highest temperature, 71°, occurred on the 17th; the lowest, 20°, on the 28th.

Cloudy weather prevailed; rain fell on 11 days and snow on 1. The total snowfall was about 0.3 inches, and the total rain and melted snow 1.76 inches. This is 1.32 inches below the Station average for November. The greatest daily rainfall was 0.52 inch, the 17th.

Numerous frosts occurred during the month.

Lunar halos were observed on the 21st and 28th.

Fogs occurred on the 13th and 14th.

The prevailing wind was south.

December.

The mean barometer was 30.115. The highest barometer, 30.487, occurred on the 19th; the lowest, 29.657, on the 3d.

The mean relative humidity was 78.1 per cent.

The mean temperature, 30.7°, is 0.9° below the Station average for December. The highest temperature, 53°, occurred on the 21st; the lowest, 6.5°, on the 30th. The temperature fell below 32° on every day except the 17th and 21st.

Cloudy weather prevailed; rain fell on 9 days and snow on 3. The total snowfall was 8.5 inches, and the total rain and melted snow, 2.38 inches. This is only 0.11 inch below the Station average for December. Snow fell on the 25th, 26th and 27th, but was almost gone by the end of the month.

A fog occurred on the 31st, in connection with rain and melting snow.

The prevailing wind was south.

METEOROLOGY.—TABLE I.—DAILY RAINFALL AT THE OHIO EXPERIMENT STATION FOR 1890.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.40		.04		.07		.45			.01		.05
2	.27	T								T	.04	
3		.04		.41	.03			.14		T		.22
4	.28	.20	.01	.02	.04		.03	.20	.10	.23		.01
5	.24		.10		.02	.08		.06	.66	.06		
6	.60		.01	T		.44			2 36	.35		
7	.65	.59		.02	.08					T		
8	.01	.24		.05			.04		.40		.22	.30
9	.04			.79	.21	.03		.07	.01		.17	
10	T		.30	.19	.79	.14			.95	.12	.12	
11	.01		.98			.15			1.22	.05	.01	
12	.20		.61			.47			.12	T	.31	
13	23		.75	T	.28		.37		.15	.22	.01	
14		.85		.30	.43	.32		T				
15	1.56	.06	.01			1.48			.01		.25	
16	.03		T		.15					.48	.06	.30
17						.37	T	1.40			.52	.05
18			.04		.59	.02		.13		.03		
19	.13	.59	.34		.39			.34	.01	.03		
20	.47	.26	T		.01			.01				.01
21		T	.09		.01	.12		.65			T	.34
22		T	.30		T							
23	.18	.04		.01	.09		.14			.79		
24		1.72		.59	.43	.01	.37			T		
25	T	1.01	.02		1.07		.01	.14	.09	.01		
26	.02			1 62				.57	1.53	.04		.80
27	.01	.25	.45	.08					.54		.03	.05
28		.03	.64			.26				T		
29	.17		.10			.41				.29		
30	T		.09			1.13			.01	T	.02	
31												.25
Totals	5.50	5.88	4 88	4.08	4.69	5.43	1.41	3.71	8.16	2.71	1.76	2.38
Av. daily rainfall	0.177	0.210	0.157	0.136	0 151	0.181	0.045	0.120	0.272	0.087	0.059	0.077

METEOROLOGY.—TABLE II.—Daily Mean Temperature at the Ohio Experiment Station for 1890.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept	Oct.	Nov.	Dec.
1	53.8	36.2	19 9	35.8	48.5	71.0	78 0	79.0	59 0	60.7	46.0	32.5
2	46.5	41.9	20.0	47.0	53.8	70.5	77.5	82.5	66.7	61.8	44.2	25.0
3	33.9	56 2	28.5	58.0	61 0	77.0	72.0	82.5	67.8	60 0	36.3	29.5
4	41.2	63.0	26.8	46.8	63 0	78.5	71.5	78.3	71.5	59.0	36.5	26.0
5	56.2	42.5	14.5	43 0	53.8	73.5	65.3	74.2	70.7	64.0	49.7	31.5
6	48 2	30.5	12.8	55 5	43.8	70.2	71.8	70.0	74.8	64.0	55.3	32.5
7	33.4	36.2	19.1	60.0	43.8	64.0	79.7	67.0	76.0	54.2	62.5	27.2
8	37 0	24.1	23 0	68.2	50.8	63.0	81.8	73.0	72.2	55.8	47.5	20 3
9	38.8	24.6	30 8	49.5	57.0	67.5	68.0	76.5	65.0	58.0	57.5	25.0
10	55.0	29.9	36 2	37.2	55.2	70.8	64 7	62.0	62 3	65.2	42.7	36.0
11	62 0	38.8	54 0	48.5	50.5	69 5	68.8	61.3	68.2	58.0	43 5	39.5
12	62.8	30.5	52.2	63 0	60.5	68 5	76.2	66.2	67.0	68.9	39 5	27.0
13	32.8	40.0	39.8	62.5	61.8	71.5	69.0	73.8	57.3	67.3	42.8	28.2
14	33 8	45.5	35 8	47.8	54.2	71.0	77.5	67.2	57.2	47.2	41.0	33.8
15	42.2	37.0	19 5	40.8	59.5	72.2	79.3	70.5	61.3	52.8	46.5	30.5
16	25.0	40.0	27.0	48.2	53 2	75.0	77.2	72 5	60.7	52 2	48 0	34.2
17	25.9	51.8	34.8	51.5	54.2	75.2	81.3	76.0	56.3	53.0	57.7	33.0
18	31.8	46.0	41.5	47.8	58.5	70 5	68.7	67.8	61 7	51.5	49.3	34.5
19	47.8	40.1	33 5	41.5	62.0	71.0	64.2	70.5	60.5	49.0	43.0	29.5
20	33.9	31.2	48.5	47.8	50.2	72.5	63.0	70 2	52.5	42.0	41.5	39.0
21	23.4	22.5	55.5	50.8	57.0	79.0	65.5	68.3	52.5	47.0	52.2	42.0
22	17.1	33.0	41.8	59.0	70.2	80.0	67.5	60.2	59.8	49.3	39.5	39.3
23	29.8	39.5	35.8	60.2	70.5	80 8	69.0	56.5	58.5	49.5	37.0	35.2
24	13.6	57.8	43.6	50.2	73.0	79.5	71.0	59.3	55.5	50.2	42.0	25.8
25	35.2	54.8	53.0	51.2	66.0	78.0	71.0	65.5	57.0	46.5	41.3	24.2
26	49.2	41.8	38.8	59.2	65.5	80.2	68.5	63.7	63 2	43.0	30.2	23.0
27	34.5	47.0	40.2	50.2	61.0	71.8	70.5	66.5	48.8	38.0	30 0	26.5
28	31.6	34.0	35.0	53.2	64.8	76.0	72.8	64.0	47.0	40.8	30.0	22.8
29	35.5	.....	34.2	58.8	70 8	78.8	77.3	65 8	52.7	38.2	35 8	29.0
30	41.2	.....	33.2	59.0	73.5	75.8	86.1	57.0	57.3	37.8	36.2	28.7
31	49.0	.....	33.1	.....	72.0	.....	84.5	56.2	.....	37.0	.....	40.3
Mean for month.	38.8	39.9	34.3	52.6	59.3	73.4	72.9	68.5	61.4	52.3	43.5	30.7

METEOROLOGY.—TABLE III—Comparison of Mean Temperature, Mean Relative Humidity and Rainfall for 1890.

	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Mean temperature at the Station	38 8°	39 9°	31 3°	52 6°	59.3°	73 4°	72 9°	68.5°	61.4°	52.3°	43 5°	30.7°	52 3°
Eight-year average temperature at the Station	25.8	29 9	35 6	49.5	61 2	69 5	73 2	69 6	63.2	48 9	40.2	31 6	49 8
Mean relative humidity at the Station	86.8%	80 7%	77 3%	71 1%	78 6%	75 2%	71.9%	77 3%	83 4%	83 7%	78.(%	78 1%	78.5%
Eight-year average humidity at the Station	8' 8	87 1	82 4	75.7	79.1	80.3	77.0	78 5	79 2	81.2	82 8	83 6	81 4
Mean temperature for the State	38.8°	39.4°	34 5°	51.3°	59.2°	73 3°	73 1°	68 8°	62.1°	52.7°	43 9°	31 2	52 4°
Eight-year average temperature for the State	26 6	30.2	35.9	49 3	60 6	69 5	73.2	69 7	63.5	51.3	41.1	32.2	50.3
Mean relative humidity for the State	84.8%	83 2%	81.3%	71 2%	79.1%	77 6%	73.1%	78 0%	83 9%	87 6%	80.1%	79 1%	80.2%
Eight-year average humidity for the State	82.8	82.4	78.3	72 6	71.2	76.3	74.2	75.6	77.2	78.7	79.2	81 0	77 7
	Inches.	*Inches*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches*	*Inches*	*Inches.*
Rainfall at the Station	5.50	5.88	4.88	4.08	4.69	5.43	1.41	3.71	3.16	2.71	1.76	2 38	50.59
Eight-year average at the Station	3.76	3 89	2.98	3.04	5 27	3.53	2 69	2.95	3.43	2.52	3.08	2.49	39 74
Mean rainfall for the State	4 91	5.25	5.29	3.15	5 52	4 50	1 99	4 70	5.56	4 27	2 53	2 37	50 33
Eight-year average for the State	3.35	3.82	2.73	2.77	4.27	3 85	3 37	3.37	3.31	2.78	3.04	2 55	40 89

METEOROLOGY—TABLE IV—Summary by Months for 1890.

Month.	Barometer.						Mean relative humidity.			
	Mean.	Highest.	Date.	Lowest.	Date.	Range.		Mean.	Highest.	Date.
At the Experiment Station.										
January	30.204	30.762	22d.	29 663	12th.	1.099	86.8	38 8	68 0	13th.
February	30.074	30 498	9th.	29.488	14th.	1.010	80.7	39 9	66 0	4th.
March	30.096	30.566	9th.	29.286	27th.	1.280	77.3	34 3	63 0	21st.
April	30.106	30.521	*3.	29 456	9th.	1.065	71.1	52 6	75 0	*4.
May	29 940	30.317	11th.	29 587	5th.	.730	78.6	59 3	86 0	30th.
June	29.985	30 336	8th.	29 757	6th.	.579	75.2	73.4	94.0	29th.
July	30 005	30 247	20th.	29.683	2d.	.564	71.9	72.9	95 0	*7.
August	30 045	30.276	24th.	29.714	26th.	.562	77.3	68 5	94 5	2d.
September	30.104	30 368	28th.	29.872	12th.	.496	83 4	61 4	87.0	*8.
October	29 951	30 252	9th.	29 361	29th.	.891	83 7	52.3	82 0	*9.
November	30.096	30 367	11th.	29 624	17th.	.743	78.0	43.5	71 0	17th.
December	30.115	30.487	19th.	29 657	3d.	.830	78 1	30.7	53 0	21st.
Sums and averages	30.060	30.762	Jan. 22.	29.286	Mar. 27.	1.476	78.5	52.3	95 0	*18.
For the State.										
January	30.212	30.830	22d.	29.363	13th.	1.467	84 8	38 8	75 0	12th.
February	30.092	30.546	9th.	29.411	14th.	1.135	83 2	39 4	73.0	4th.
March	30.101	30 641	9th.	29.220	28th.	1.421	81.3	34 5	69 0	*12.
April	30.121	30 622	1st.	29 259	9th.	1 363	74.2	51 3	86.0	8th.
May	29.954	30.376	11th.	29.521	5th.	.855	79 1	59 2	92 0	30th.
June	29.997	30 388	8th.	29.703	6th.	.685	77.6	73.3	101 0	28th.
July	30.016	30.348	21st.	29.638	2d.	.710	73.1	73 1	101.0	31st.
August	30 058	30.359	23d.	29.651	26th.	.708	78 0	68.8	103.1	3d.
September	30 118	30.455	28th.	29.806	12th.	.649	83.9	62 1	92.0	7th.
October	29.956	30 312	22d.	29 275	29th.	1.037	87.6	52 7	85.0	*16.
November	30.101	30.470	22d.	29 553	2d.	.917	81.1	43 9	76 5	17th.
December	30.125	30 568	19th.	29.581	3d.	.987	79 1	31 2	65.0	11th.
Sums and averages	30.071	30.830	Jan. 22.	29.220	Mar. 28.	1.610	80 2	52.4	103.1	Aug. 3.

*1—14th and 25th. *2—9th and 20th. *3—1st and 2d. *4—8th and 22d. *5—6th and 21st. *6—2d 7th and 27th. *12—11th and 14th. *13—2d and 31st. *14—2d and 10th. *15—10th and 20th. *16—12th

METEOROLOGY—TABLE IV—SUMMARY BY MONTHS FOR 1890.

Temperature.								No. of days.						
Lowest.	Date.	Range.	Mean daily range.	Greatest daily range.	Date.	Least daily range.	Date.	Clear.	Fair.	Cloudy.	Rain fell.	Monthly rainfall.	Average daily rainfall.	Prevailing wind.
8 5	22d.	59.5	17.6	41.0	13th.	5.0	29th.	5	9	17	19	5.50	0.177	S.
16.0	9th.	50 0	17.2	33.0	11th.	5.0	*1.	7	7	14	13	5.88	0.210	N. W.
4.0	6th.	59 0	15.3	24.0	*2.	3.0	31st.	5	12	14	18	4.88	0.157	N. W.
27 0	1st.	48 0	21.1	36.0	*5.	9 0	15th.	13	7	10	11	4 08	0. 36	N. E.
32 0	2d.	51.0	20.1	34.0	2d.	6.0	7th.	7	10	14	17	4 69	0. 51	S.
48.0	8th.	46 0	21.6	30.0	*6.	14 0	12th.	12	16	2	15	5 43	0.181	S.
45.0	21st.	50 0	23 8	37.0	12th.	10.0	13th.	24	5	2	7	1.41	0.045	S.
43 0	31st.	51.5	22.1	35 0	16th.	9.0	21st.	13	12	6	11	3 71	0 120	S.
36 0	28th.	51.0	20 6	32.0	21st.	7.0	10th.	7	17	6	15	8.16	0.272	S.
31.0	30th.	51.0	17 2	31 0	9th.	6.0	2*d.	6	12	13	14	2.71	0.087	S.
20 0	28th.	51 0	18.6	35 0	5th.	6 0	*10.	5	10	15	12	1.76	0.059	S.
6.5	30th.	46 5	14.3	32 5	30th.	2.0	17th.	11	8	12	11	2 38	0 077	S.
4.0	Mar. 6.	91 0	19.1	41 0	Jan. 13.	2.0	Dec. 17.	115	125	125	163	50.59	0.139	S.
0.7	22d.	74.3	17.9	49.3	13th.	3.0	*11.	5.0	9.1	16.9	16.0	4.94	0.159	S. W.
5.0	9th.	68 0	18.6	46.0	17th.	2.0	9th.	5.8	5.6	16.6	12.1	5.25	0.188	S. W.
-4.0	7th.	73 0	16.3	37.0	9th.	3.0	*13.	4.5	10.5	16.0	15.2	5.29	0.171	N. W.
20.0	*4.	66 0	22.7	49.5	11th.	3.0	24th.	11.5	8 8	9.7	10.7	3.45	0.115	N. E.
28 0	2d.	64.0	21.0	44.0	17th.	4.0	4th.	8.0	10.9	12 1	.....	5 52	0.178	S. W.
38.8	8th.	62.3	21 5	42.0	3d.	7.0	27th.	11.2	14.2	4.6	.....	4.50	0.150	S. W.
42.5	21st.	58 5	22.8	41 0	7th.	4.0	9th.	17 8	10.3	2.9	5 6	1.99	0.064	S. W.
39.5	24th.	63 6	20.4	44 1	12th.	4.0	14th.	10.8	12.4	7.8	9 6	4.70	0.152	S. W.
33 0	29th.	51 0	19.4	44.0	20th.	4.0	*15.	9 6	10.7	9 7	11.4	5.56	0.185	S. W.
28.7	30th.	56.3	16.3	39.5	15th.	3.7	29th.	4 5	10.0	16.5	15 5	4.27	0.138	S. W.
17 0	28th.	59.5	17.0	44.0	5th.	3 0	*17.	8 0	8.7	13 5	8 8	2.53	0.084	S. W.
3.0	30th.	62 0	14.5	38 3	30th.	.0	17th.	6.7	10.3	14 0	10 0	2.37	0.076	S. W.
-4 0	Mar. 7.	107.1	19.0	49.5	Apr. 11.	1 0	Dec. 17.	103.1	121.6	140.3	149.4	50.33	0.138	S. W.

and 26th. *7—8th and 15th. *8—7th and 8th. *9—12th and 13th. *10—11th, 16th and 27th. *11—6th, and 13th. *17—3d and 27th. *18—July 8th and 15th.

METEOROLOGY.—TABLE V.—MONTHLY RAINFALL AT THE EXPERIMENT STATION FOR EIGHT YEARS.

Year.	Jan.	Feb.	March.	April.	May	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
	Inches	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1883	2.90	5 81	2 87	2 98	5.76	4.70	2 92	2.12	3 13	4 34	3 87	4.97	46.37
1884	2.77	5 29	4 10	2 40	4 34	1.11	2.23	0.45	4.23	1.49	1.13	3 87	33 41
1885	4.03	3.17	0 98	4.51	5.92	4.84	3 01	5 50	2 00	3.12	2.89	1 68	41.65
1886	4.49	1.67	2.83	3.25	6 91	2.23	3.01	1.42	3 42	1.19	4.18	3 41	38.01
1887	1.54	6 85	2.84	4 45	4 36	5 47	1 56	2 47	1 82	0 38	2.64	2 04	36.62
1888	4 04	1.71	4.33	2.39	6 67	2 43	4.72	5.85	1 26	5 14	4.30	1 36	44 20
1889	3.90	0.81	1 00	1.11	3 46	2 08	2 85	2 07	3 77	1.79	3 72	2 24	28.80
1890	5 50	5.88	4.88	4 08	4 69	5.43	1 41	3 71	3 16	2 71	1 76	2.38	50 59
Average	3 76	3.89	2.98	3.04	5 27	3.53	2 69	2.95	3 43	2 52	3 08	2 49	39 74

METEOROLOGY—TABLE VI.—Summary by Years, and Grand Summary for Eight Years.

	1883.	1884.	1885.	1886.	1887.
At the Experiment Station.					
Mean relative humidity	82 3 per cent	82.3 per cent.	84 2 per cent	82.7 per cent.	79.2 per cent.
Mean temperature	49.1°	50 1°	47 4°	49.2°	50 8°.
Highest temperature	97 0°, August 22	97.0°, August 20	101.0°, July 21	97.5°, June 4	102 5°, July 17.
Lowest temperature	—7 0°, January 12	—32.0°, January 25	—20.0°, Feb. 21	—12.0°, Feb. 17	—10 0°, Jan. 11.
Range of temperature	104 4°	129.0°	121 0°	109 5°	112 5°.
Mean daily range of temperature	22.9°	24.8°	23 1°	23.6°	24.1°.
Greatest daily range of temperature.	45 °, September 11	49 5°, July 22	55 0°, Feb. 2	48.0°, Feb. 17	47 5°, Sept. 5.
Least daily range of temperature	1.8°, January 28	4 0°, Feb. 22	4.0°, Dec. 10	5 0°, Feb. 7	3 0°, Dec. 12.
Number of clear days	105	103	83	107	98.
Number of fair days	147	119	137	145	130.
Number of cloudy days	113	144	145	113	137.
Number of days rain fell	165	149	166	154	158.
Total rainfall	46.37 inches	33.40 inches	41 65 inches	38.01 inches	36 62 inches.
Mean daily rainfall	0.127 inch	0 091 inch	0114 inch	0.104 inch	0.100 inch.
Greatest monthly rainfall	5 81 inches, Feb	5.29 inches, Feb	5.92 inches, May	6.91 inches, May	6.85 inches, Feb.
Least monthly rainfall	2.12 inches, Aug	0 45 inch, Aug	0 98 inch., March	1 19 inches, Oct	0.33 inch, Oct.
Warmest day of year	82.7°, July 23	80.5°, July 23	85 8°, July 31	81.9°, July 29	87.0°, July 17.
Coldest day of year	1 0°, Jan 22	—16.8°, Feb. 6	—4.0°, Feb. 10	—5.05°, Jan. 10	0 6°, Jan. 10.
Prevailing direction of wind	N. W.	S. W	S. W	S. W	S. W.
For the State.					
Mean relative humidity	76.3 per cent	76.8 per cent.	77.5 per cent	77 8 per cent.	75.8 per cent.
Mean temperature	49.4°	50 6°	48.0°	49.6°	51.4°.
Highest temperature	98.°, August 22	99.0°, Sept. 28, and Oct 1	101 0°, July 21	98 6°, July 7	103.0°, July 18.
Lowest temperature	—17 2°, Jan. 22	—34.0°, Jan. 25	—31.0°, Jan. 29	—21 5°, Jan. 12	—21.0°, Jan. 7.
Range of temperature	115.5°	133.0°	132.0°	120.1°	129 0°.
Mean daily range of temperature	19.8°	20.5°	20.4	20 2°	21.2°.
Greatest daily range of temperature	55 2°, March 18	50 0°, Sept. 5, and Dec. 4	58.5°, Jan. 30	57 0°, Dec. 11	57 0°, April 11.
Least daily range of temperature	0 5°, December 23	1.1°, Feb. 6	1 0°, April 18 and Dec. 31	1 1°, March 27.	1.0°, Jan. 15 and Apr. 16.
Number of clear days	98.2	116.7	103 5	118.4	113.8.
Number of fair days	135.4	118 3	132.8	125.7	127.3.
Number of cloudy days	130.4	131.1	128.2	121.0	123.9.
Number of days rain fell	146.0	145.0	147 7	130.7	120.9.
Mean yearly rainfall	44.98 inches	40.19 inches	38.08 inches	36 71 inches	33 63 inches.
Mean daily rainfall	0.123 inch	0.110 inch	0.104 inch	0.100 inch	0.092 inch.
Prevailing direction of wind	S. W.	S. W	S. W	S. W	S. W.

METEOROLOGY—TABLE VI.—Concluded.

	1888.	1889.	1890.	Summary for eight years.
At the Experiment Station.				
Mean relative humidity	82.8 per cent	79.8 per cent	78.5 per cent	81.4 per cent.
Mean temperature	49.6°	51.2°	52.3°	49.8°.
Highest temperature	98.0°, June 20	93.0°, Aug. 31 and Sept. 1	95.0°, July 8 and 15	102.5°, July 17, 1887.
Lowest temperature	—11.0°, Jan. 28	1.0°, Feb. 23	4.0° March 6	—32.0°, January 25, 1884.
Range of temperature	109.0°	92.0°	91.0°	134.5°.
Mean daily range of temperature	21.1°	20.8°	19.1°	22.4°.
Greatest daily range of temperature	43.2°, April 28	41.5°, April 23	41.0°, January 13	55.0°, Feb. 2, 1885.
Least daily range of temperature	4.1°, Aug. 21	3.0°, Jan. 6 and Nov. 20	2.0°, December 17	1.8°, January 28, 1883.
Number of clear days	96	124	115	103.8.
Number of fair days	141	113	125	132.0.
Number of cloudy days	129	128	125	109.2.
Number of days rain fell	142	163	163	157.0.
Total rainfall	44.20 inches	28.80 inches	50.59 inches	39.74 inches.
Mean daily rainfall	0.120 inch	0.079 inch	0.139 inch	0.109 inch.
Greatest monthly rainfall	6.67 inches, May	3.90 inches in January	8.16 inches in September	8.16 inches in September, 1890.
Least monthly rainfall	1.26 inches, Sept.	0.81 inch in February	1.41 inches in July	0.39 inch in October, 1887.
Warmest day of year	84.1°, June 20	80.5°, July 9	86.1°, July 30	87.0°, July 17, 1887.
Coldest day of year	7.5°, Feb. 9	4.9°, February 23	12.8°, March 6	—16.8°, February 6, 1884.
Prevailing direction of wind	S. W	S. W	S	S. W.
For the State.				
Mean relative humidity	78.2 per cent	79.4 per cent	80.2 per cent	77.7 per cent.
Mean temperature	49.5°	51.1°	52.4°	50.3°.
Highest temperature	102.0°	99.5°, August 31	103.1°, August 3	103.0°, July 18, 1887.
Lowest temperature	—15.0°, Jan. 27	—13.5°, February 24	—4°, March 7	—34.0°, Jan. 25, 1884.
Range of temperature	117.°	113.0°	107.1°	142.0°.
Mean daily range of temperature	19.6°	19.3°	19°	20.0°.
Greatest daily range of temperature	50.0°	53.0°, March 30	49.5°, April 11	58.5°, Jan. 30, 1885.
Least daily range of temperature	1.2°, Jan. 16	1.0°, January 5	1.0°, December 17	0.5°, Dec. 23, 1883.
Number of clear days	108.7	112.8	103.4	109.4.
Number of fair days	123.4	113.8	121.6	124.7.
Number cloudy days	133.9	138.4	140.3	130.8.
Number of days rain fell	124.7	114.8	149.4	134.9.
Mean yearly rainfall	39.64 inches	33.53 inches	50.33 inches	40.89 inches.
Mean daily rainfall	0.108 inch	0.092 inch	0.138 inch	0.108 inch.
Prevailing direction of wind	S. W	S. W	S. W	S. W.

W. H. BAKER, *Meteorologist.*

THE INSECT RECORD FOR 1890.

BY CLARENCE M. WEED, ENTOMOLOGIST AND BOTANIST.

The year 1890 in Ohio was not characterized by any specially serious outbreak of injurious insects, although a number of well known pests appeared above the danger line in several localities, doing considerable damage. The most wide-spread attention was probably attracted by three shade-tree insects—the WOOLLY MAPLE BARK-LOUSE, the WALNUT CATERPILLAR and the larva of the WHITE-MARKED TUSSOCKMOTH—which appeared in a large number of cities and villages in the State, causing much apprehension as to the safety of the trees.

Attention was called to the presence of the WOOLLY MAPLE BARK-LOUSE (*Pulvinaria innumerabilis*) early in the summer, when the citizens of Cleveland, Canton, Columbus and various other cities and villages discovered that the twigs of their maple trees were infested, especially on the underside, by brown leathery scales, about one-quarter of an inch in diameter, beneath which were fluffy cottony masses (Fig. 1, *a*) that often were found to be alive with hundreds of young lice, appearing to the unaided eye as minute white specks moving about. As soon as inquiries regarding this insect began to come in, a newspaper bulletin was issued concerning it, which was very generally published by the county and local papers of the State. It seems worth while to republish in this connection the following paragraphs from the bulletin in question:

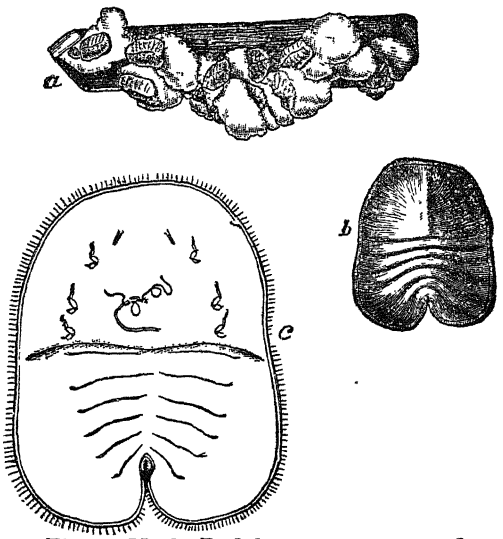

Fig. 1. Maple Bark-louse: *a*, cottony scales on twig; *b*, back view of scale, magnified; *c*, ventral view of scale, more magnified. [After Riley.]

About six years ago there was a similar outbreak of this insect in Ohio, Illinois, Michigan and adjacent States, when many trees were rendered unsightly and filthy by the presence of the lice, and some were killed by the attack.

This Maple Bark-Louse is an insect belonging to a family of peculiar habits and histories. Under each of the scales there was a month ago from 700 to 1,000 small white eggs. These eggs have since hatched into young lice that are now scattering over the trees and will soon fix themselves upon the leaves where they will remain throughout the season. They insert a tiny beak into the leaf and suck the sap. In autumn before the foliage drops they desert the leaves and fasten themselves to the twigs. Much of the sap that is sucked from the leaves passes through their bodies and falls to the ground. This is frequently called honey-dew.

Some of the most intelligent citizens of Columbus report that during the outbreak of 1884 they cleared their shade-trees of the scales and young lice, by washing them off with a stream of water thrown from the hose. In cities this is the simplest and easiest plan to be suggested. Of course a single washing can not be expected to clear the trees completely, but the treatment should be repeated several times. When this simple water treatment is not practicable the next best method is that of spraying with kerosene emulsion. This is made by adding two parts of kerosene to one part of a solution made by dissolving half a pound of hard soap in a gallon of boiling water, and churning the mixture through a force pump with small nozzle until the whole forms a creamy mass that will thicken into a jelly-like substance on cooling. The soap solution should be hot when the kerosene is added, but of course must not be near a fire. The emulsion thus made is to be diluted before using with twelve parts of cold water. This must be applied soon after the lice hatch with a force pump and spray nozzle. Care should be taken that the kerosene is thoroughly emulsified, else it is liable to injure the foliage.

These bark-lice have various natural enemies which prey upon them. These enemies checked the outbreak quite suddenly in 1885, and probably in a year or two they will reduce their present numbers below the danger line. But in the meanwhile artificial remedies should be used as much as possible.

During July and August the walnut trees over a large section of the State were defoliated by the walnut caterpillar (*Datana angusii*). This insect is the larva or caterpillar of a good sized moth that makes its appearfrom the middle of June to the first of July, and deposits its eggs, seventy or a hundred in a place, on the under surface of the leaves. In a short time larvæ hatch from these eggs, and feed upon the leaves. They rapidly increase in size, and in a few weeks attract attention on account of the defoliated twigs where they have been at work. They are gregarious in habit, and at the times of moulting or casting of the skin, they migrate in a body to the trunk of the tree, frequently descending nearly to its base, and piling themselves one upon another remain in a solid mass until the process is completed. Then they crawl back to the twigs and begin feeding again. When full grown as caterpillars they go to the ground and change to the pupa state just beneath the soil surface. Here they remain until early the following summer, when they change again to moths.

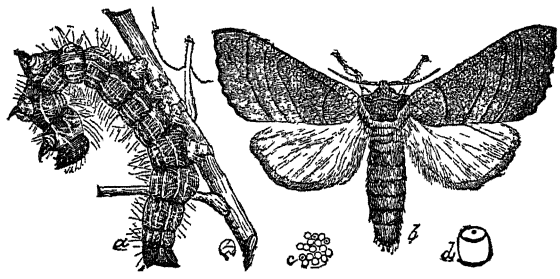

Fig. 2. Yellow-necked Apple Worm; *a* larvæ; *b*, moth; *c*, *d*, eggs. [After Riley.]

A fair idea of the appearance of the Walnut Caterpillar, and its moth may be obtained from Fig. 2, which represents a closely allied species, the YELLOW-NECKED APPLE-TREE CATERPILLAR (*Datana ministra*)—an insect that also attracted some attention during the year on account of its injuries in the apple orchard.

Fortunately the Walnut Caterpillar has many enemies. There are a number of species of predaceous and parasitic insects that prey upon it, and it also serves as food for certain birds. So far as our observations go the Blue Jay is the most important of these. An assistant, Mr. E. V. Wilcox, who was requested to make observations upon this subject, in a report submitted late in August, says:

There are several trees on the Station Farm which I have seldom passed since the twentieth of July without seeing one or more Blue Jays eating the caterpillars. During the last two weeks they have been especially active. One morning I saw a flock of twenty or thirty in a walnut tree busily engaged getting a breakfast; and as they are very voracious birds, it seems to me that they must be effective destroyers of this insect. They not only devour many of the larvæ but they interrupt their feeding in another way. The Blue Jay has a peculiar habit which I never noticed till last year and of which I see no explanation except the playful disposition of the bird. I have observed Blue Jays pick acorns from an oak, drop them to the ground watching and listening until they struck, and then repeating the experiment. The morning of August 14th last, I was attracted to a walnut tree by the cries of Blue Jays. I watched them for about thirty minutes and noticed one old Blue Jay deliberately picking the caterpillars from the leaves and dropping them to the ground with evident satisfaction to himself. The caterpillars require some time to regain the top of the tree even if they should not, which rarely happens, be too badly crushed by the Blue Jays to do any further damage. There was a large number of birds in this tree but the others were too busy satisfying their appetites to drop any caterpillars except by accident.

The Columbus Blue Jays are not the only ones that have found how easily they can make a feast on these larvæ. I have observed Blue Jays eating the same species of caterpillar in Central College, Galena, Flint, Westerville and other places along the Olentangy river, Alum creek and Big Walnut creek. An ornithological friend of Westerville tells me that he has frequently seen Cookoos and Blue Jays, and more rarely Red-headed Woodpeckers, eating these larvæ.

Many of the defoliated trees pushed out a new crop of leaves during the late summer and early autumn months.

The injuries of the third of these shade tree pests—the caterpillar of the WHITE-MARKED TUSSOCK-MOTH—did not attract attention until late in the summer. Then, however, the injury became so serious in many cities and villages, that it was universally noticed. As examples of many others received I publish below two letters concerning the injuries of the pests. The first is from Mr. W. M. Hill, an observing entomologist of Columbiana county, who, under date of September 2, 1890, wrote:

For some time past I have been very much interested in the increasing numbers of the caterpillar of the White-marked Tussock-Moth. Not for many years has this locality been visited by such a destructive pest. I have found the larvæ feeding on almost all of our shade and fruit trees, and many are completely defoliated by them.

We have the second brood with us now, and it is five times as large as the first. The buckeye trees seem to be the greatest attraction for them, with the maple a close second. While they do not seem at all particular as to their food, they have committed their ravages principally upon the above two.

The second letter came from Hanlon Bros. & Co, proprietors of the Barnesville (O.) *Republican*, and is dated August 19, 1890. It reads:

In the enclosed envelope you will find a kind of caterpillar that has been doing much damage to shade trees at this place. The trees are full of them. They spin a thread, and hundreds of them can be seen suspended from the trees along the streets. A number of citizens have been compelled to cut down valuable shade trees. Can you send us for publication any information concerning them which may prove of value. Please let us hear from you immediately.

If the trunks or large limbs of maple, apple, elm, or any other of the trees infested by this insect be examined any time during autumn or winter, after the leaves have fallen, one may find, scattered here and there upon the bark, thin gray cocoons, many of which will be covered with large bunches of spherical white eggs, fastened together by a protecting froth-like mass. In May, soon after the leaves come out, these eggs hatch into small caterpillars that at once begin eating the foliage about them. They continue to devour it for six or seven weeks, when they become full grown. They are then very handsome (Fig. 3), and measure a little over an inch. The general color is bright yellow. The head and two tubercle-like projections on the hinder portion of the back are of a bright coral red. There are four cream colored tufts of hair along the back. Two long black plumes project forward from just behind the sides of the head, and another projects backward from the posterior end of the body. About the middle of July the caterpillars spin thin whitish cocoons upon the rougher bark, and a fortnight later come forth as moths.

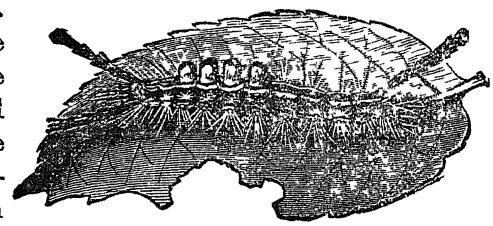

Fig. 3. Caterpillar of White marked Tussock moth. [After Riley]

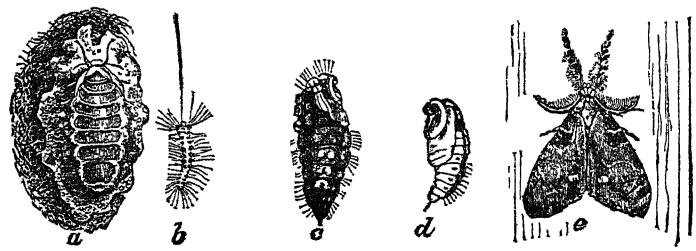

Fig. 4. White-marked Tussock moth; *a*, female moth on cocoon; *b*, young larva, hanging by thread; *c*, female pupa, *d*, male pupa, *e*, male moth. [After Riley.]

These lay eggs for a second brood which completes its transformations before winter sets in. The pupa of the female (Fig. 4, *c*) is larger than that of the male (*d*). The male moth differs greatly from the female moth, the former being winged (*e*) while the latter is wingless. The female crawls upon top of the cocoon (*a*) as soon as she emerges from the pupa state, where after mating with the male, she deposits her eggs in a single mass, often containing several hundred, and dies.

The increase of this insect is greatly checked by several parasitic enemies, nearly a dozen species of two-winged and four-winged flies being known to be parasitic upon it. The caterpillars may be destroyed by spraying the infested trees with the arsenites—Paris green or London purple—or the egg masses may be picked off the bark during the winter.

It will be remembered that the year 1889 was remarkable for an outbreak of the GRAIN PLANT LOUSE (*Siphonophora avenæ*), and that over a large portion of the State the outbreak was checked by various predaceous and parasitic insect enemies, although this did not occur before serious injury to the grain had been done by the lice. As an indication of the amount of this damage I insert the following extract from a letter sent to the Station under date of June 10, 1890, by Messrs. Adolph Wood & Co., commission merchants of Cincinnati:

> We have kept watch of the Warren county wheat upon which we reported last year, having handled a good deal of it on our track, and beg to say that it was seriously damaged by the shriveling of the grain, as predicted in your Circular No. 2. Its commercial value was reduced greatly, say from 5 to 20 cents per bushel, and of course there was a *great loss* to the producer, but just how much we are unable to say, not having weighed any samples and kept a record.

During the present year we received information of the appearance of this insect early in summer in Butler, Clermont, Clinton, Columbiana, Hamilton, Miami, Trumbull and Warren counties. But most of the accounts also conveyed the information that the enemies of the lice were present in great numbers, so that comparatively little injury was anticipated. The extraordinary opportunities afforded by the 1889 outbreak for the increase of the ladybird beetles were shown by the abundance of these useful little creatures during the season just past. I have never before seen them so numerous. A correspondent in Miami county reported in June that noticing the abundance of the lady beetles in his corn field he examined 27 stalks taken at random and found on them 28 lady beetles. Similar information was contained in the following letter written by an observing and valued correspondent, Mr. Edwin C. Ely, from Clermont county, May 30:

> The Grain Plant-louse has appeared in great numbers upon wheat and rye. I examined eight fields and found all infested with winged, wingless and young lice. They

are attended by their parasites. Almost innumerable ladybirds are upon the wheat heads; also a small four-winged fly which I suspect of feeding on the lice, and a kind of soldier beetle that prays upon them.

During February and March complaints began coming in from many sections of the State of the presence in destructive numbers of two species of bark lice affecting fruit trees. The first of these is the OYSTER-SHELL BARK-LOUSE (*Mytilaspis pomorum*) and the second the SCURFY BARK-LOUSE (*Chionaspis furfurus*). The former especially infects the apple while the latter occurs upon both the apple and pear. An extended account of these pests was published in the April bulletin.

During the late winter months a number of accounts were also received of a peculiar injury to the twigs of fruit trees, which proved to be due to the BUFFALO TREE HOPPER (*Cresa bubalus*), an odd-looking insect that heretofore only occasionally has attracted the attention of the economic entomologist. It is a small greenish or yellowish creature, about one-third of an inch long, which is generally rather common during the late summer and early autumn months. A fair idea of its form, which has been compared to that of a beechnut, may be obtained from *a* and *b*, Fig. 5. Its mouth consists of a sharp beak, which it inserts into the bark and sucks the sap. The eggs are laid in the upper part of the twigs of apple, pear, maple and various other fruit and shade trees, mostly during the late summer or early autumn months. They hatch the following May into small, active, greenish hoppers, somewhat like the adults in appearance, which insert their tiny beaks in the tender bark and suck out the sap. They become full-grown about midsummer, and feed, in both the young and adult states, on a great variety of plants. The eggs are said to be preyed upon by a small Ichneumon parasite. A short account of the insect and its injuries was published in the April bulletin.

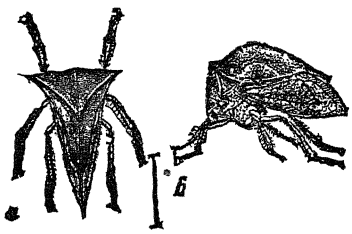

Fig. 5. Buffalo Tree Hopper, *a*, back view; *b*, side view.

The injuries of the PLUM CURCULIO (*Conotrachelus nenuphae*) have in many localities been unusually severe. In the northern Ohio fruit belt along the shores of Lake Erie, the failure of the apple crop had the effect of driving the Curculios to the peach for purposes of oviposition, and in consequence the injury of this insect to the latter crop was very great, and apparently unprecedented.

The spraying experiments upon this insect conducted on the Station grounds during 1888 and 1889 were this year transferred to a commercial plum orchard in Northern Ohio and were entirely successful.* Notwith-

*See September bulletin, pp. 225-228.

standing adverse reports from certain quarters, evidence continues to accumulate to show that by a proper use of the spraying machine the commercial orchardist may save his plums from the curculio. It seems probable also that peaches may be protected from the insect by spraying early in the season with finely powdered Paris green, mixed with water in the proportion of one ounce to 20 gallons. For plums I would now recommend one ounce Paris green to 15 gallons water. London purple should not be used on these two crops.

The few apples that were set upon the orchards of the State were severely injured by the CODLING MOTH (*Carpocapsa pomonella*), although favorable reports have been received from those that sprayed to prevent this injury.

The CHINCH BUG (*Blissus leucapterus*) has been heard from in several localities, but has done no serious and widespread damage. A Clinton county correspondent sent in a box of them late in July with the statement that they were extremely numerous over about an acre in a corn field. During the fall months they were rather common in Franklin county, and were also received from a few other regions. They are evidently present in sufficient numbers to do considerable local damage, on short notice, under conditions favorable to their development.

The HESSIAN FLY (*Cecidomia destructor*) is apparently still below the danger line in this State. Very few reports concerning it have been received.

Mention was made in my Insect Record for last year of a series of experiments with remedies for the STRIPED CUCUMBER BEETLE (*Diabrotica vittata.*) These experiments were continued this season, two general methods of treatment being employed: (1) Coating the plant with poisonous substances, and (2) fencing out the insects by mechanical barriers. The best success was attained in the first class of remedies, by the use of tobacco powder—the refuse packing of the cigar factories. A number of barrels of this substance were obtained at a cigar factory. A shovelful of the powder was thrown on each hill. The first application was made to eighty hills, June 12. Rains coming soon after, it was repeated June 14, 16 and 17. The results were excellent. The beetles seemed to dislike working in the tobacco and the plants on all the hills so treated came through in good condition. Aside from its value as an insecticide the tobacco acts both as a mulch and fertilizer. Chemical analysis shows that its market value as a fertilizer is twenty-five dollars per ton. In many eastern cities it is being utilized, but in Columbus and other Ohio cities many of the factories are glad to give this refuse to any one who will take it away.

Various methods of mechanical exclusion of the beetles were again

tried with good success. This may be done by simply placing over the plants a piece of thin plant-cloth or cheese-cloth, about two feet square and fastening the edges down by loose earth. It is better, however, to hold the center of the cloth up by means of a half barrel hoop or wires bent in the form of a croquet arch.

The IMPORTED CABBAGE WORM (*Pieris rapæ*) has suffered greatly during the latter part of the season from the attacks of a number of insect parasites and the bacterial disease known as *flacherie*.

Next to the cabbage worm the worst insect enemy of the cabbage is the APHIS or plant-louse, which is so often found upon the leaves and in the heads in great numbers. This is a small, bluish white insect, that subsists upon the sap of the plant, and multiplies with great rapidity. Like most of the peculiar family to which it belongs, this insect has the power, not common among insects, of bringing forth living young, but with most of those that have been carefully studied there is in the fall a sexual generation by which true eggs are laid, and in this egg state most of them pass the winter. But although the Cabbage Aphis has been known both in Europe and America for more than a century, the sexual generation has never heretofore been found, and entomologists did not know where or when the eggs were laid, nor how the insect passed the winter. During November, however, we discovered that the sexual gen-

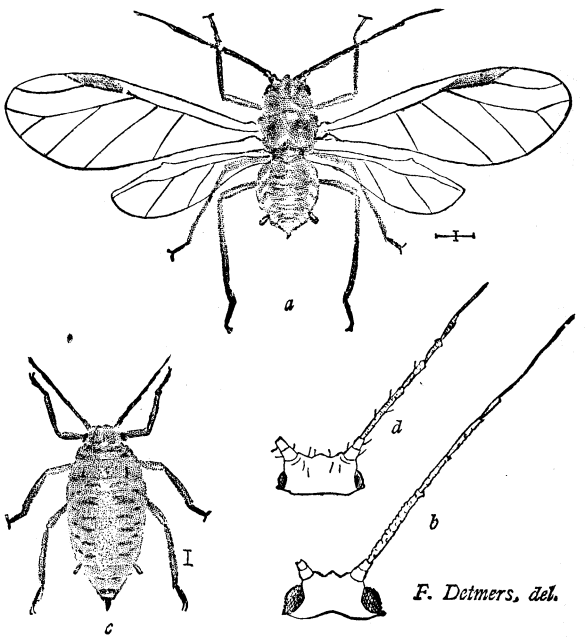

Fig. 6. Cabbage Aphis; *a*, male; *b*, head and antenna of same; *c*, oviparous female; *d*, head and antenna of same. Magnified.

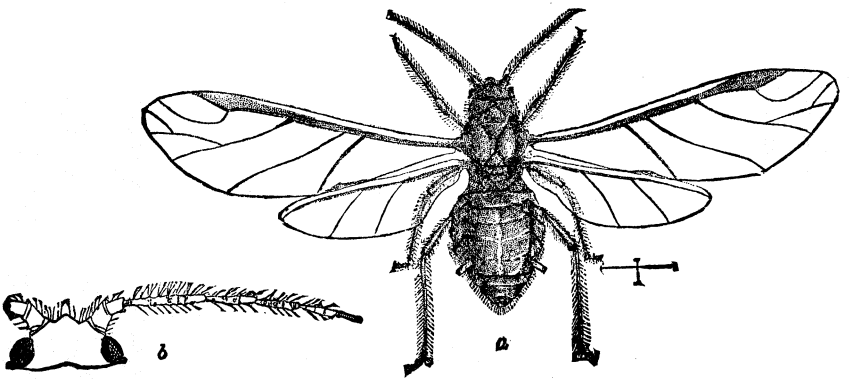

Fig. 1.

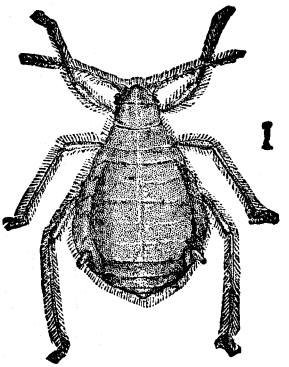

Fig. 2.

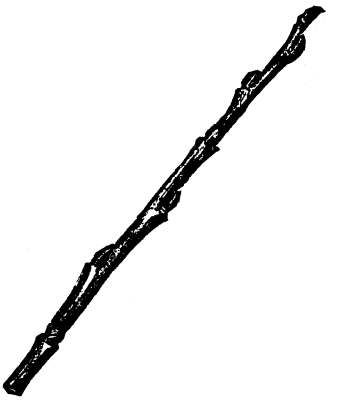

Fig. 3.

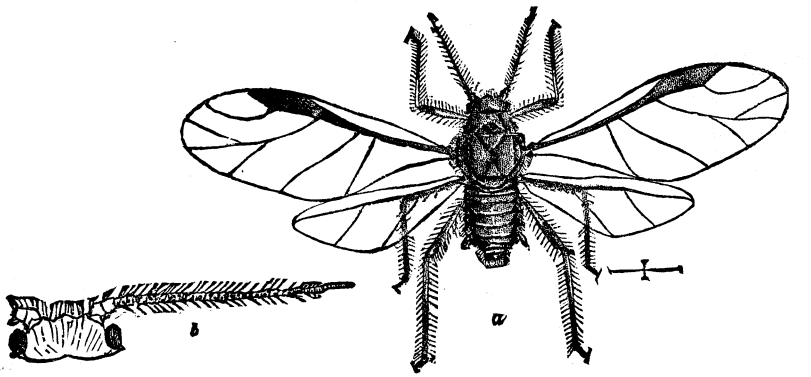

Fig. 4.

Willow Grove Plant-Louse.

eration develops late in autumn on the cabbage, and that the eggs are laid on the cabbage leaves. The true male (Fig. 6*a*) is a small winged creature, with a more slender body than the other winged forms. The egg-laying female (*c*) has no wings, and is pale green in color.

This discovery of the fact that the insect passes the winter in the egg state on the cabbage leaves has an important economic bearing. It suggests as one of the best ways of preventing the injuries of this pest, the destruction during winter of the old cabbage leaves with the eggs upon them, instead of leaving them undisturbed until spring, as is too often done.

Some complaint has been made during the year of the injuries of the WILLOW-GROVE PLANT-LOUSE (*Melanoxanthus salicti*), a large bluish-black aphis that infests the twigs of willows. They are very annoying when they occur on ornamental trees in private yards or public parks. The several stages of the insect are represented at Plate III, Fig. 1 showing the winged female that gives birth to living young; Fig. 2, the egg-laying female; Fig. 3, the small black egg deposited about the buds, and Fig. 4, the winged male. Spraying with kerosene emulsion early in the spring will probably prove an effectual remedy.

A somewhat similar insect that has done some damage to ornamental trees during the season is represented on Plate IV. It is the WHITE PINE PLANT-LOUSE (*Lachnus strobi*). Like most aphides this species reproduces viviparously during the summer but on the approach of cold weather the sexed individuals are produced. During October these are usually the only forms present, the oviparous females (Fig. 1, *a*) being congregated in great numbers upon the bark of the smaller branches of White Pines, with their heads nearly always directed toward the trunk of the tree. When disturbed they move about rapidly usually attempting to conceal themselves on the other side of the branch. At such times they also have a curious habit of waving their long hind legs in the air, probably for the purpose of frightening away enemies. The male is winged and is represented, magnified, at Fig. 2, *a*. The eggs are deposited during autumn in rows upon the leaflets, as shown at Fig. 3, *a*, a single egg magnified being represented at *b*.

About the middle of July a number of specimens of the POTATO STALK BORER (*Trichobaris trinotata*) were received from Mr. W. A. Collins, Lucas county, Ohio, with the statement that the insect had been doing considerable damage in that vicinity during this and several previous seasons. This insect has also lately been reported as very injurious in Iowa.

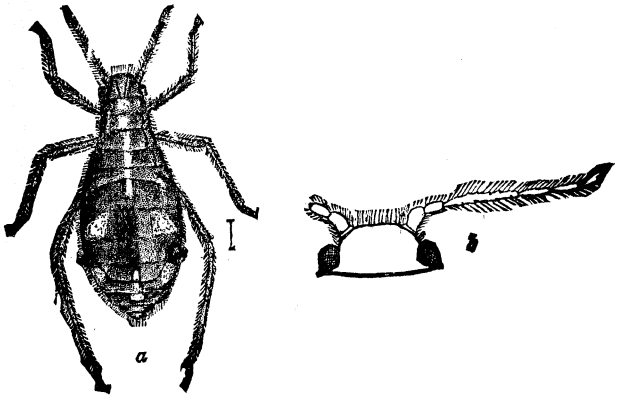

Fig. 1.

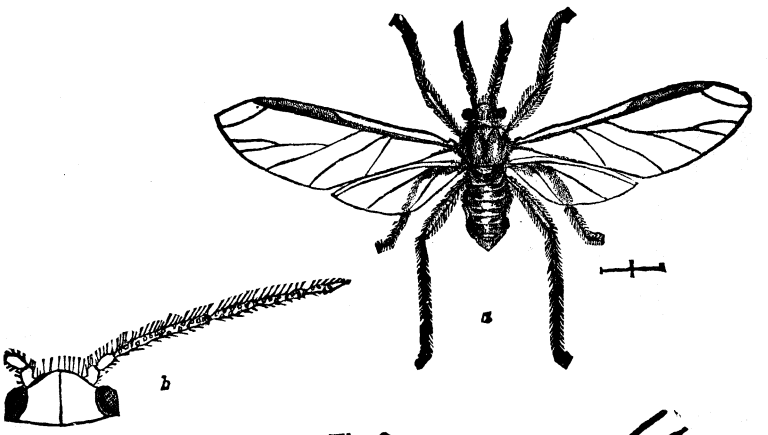

Fig. 2.

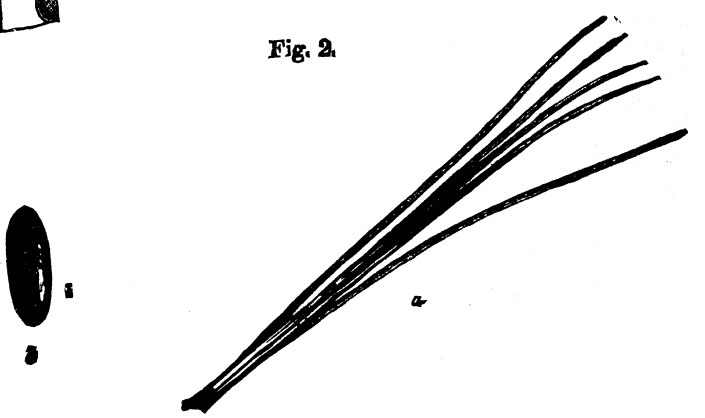

Fig. 3.

White Pine Plant-Louse.

THE APPLE MAGGOT (*Trypeta pomonella*) has also been heard from as doing some damage in Delaware county.

INSECTICIDE MACHINERY.

Several sorts of apparatus for the application of insecticides have been tested at the Station during the season. One of the most satisfactory of these was Leggett's Powder Gun for applying dry insecticides like Paris green, London purple, insect powder, tobacco dust, etc. It is represented in operation at Fig. 7. It consists of a rotary bellows, worked by a cog-wheel which throws the powder out of the long tubes with great

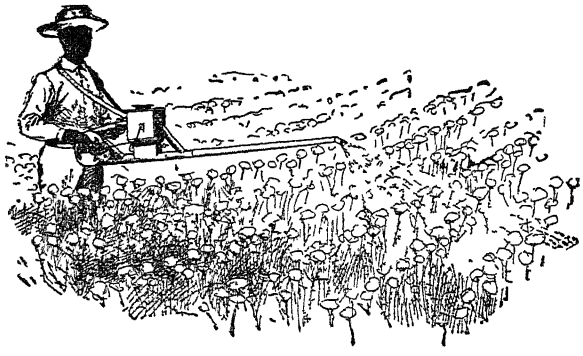

Fig 7 Leggett's Powder Gun in operation.

force. I have found it the most satisfactory instrument available for the distribution of powdered insecticides and fungicides. It is manufactured by Leggett & Brother, 301 Pearl street, New York City.

Queries frequently reach the Station concerning low-priced spraying pumps for use in small orchards and about the home grounds. There are a number of such machines upon the market. One of the most satisfactory ones which I have tried is manufactured by P. C. Lewis, Catskill, New York, the price of which delivered is $5 50. I have used this pump more or less for several years, and can conscientiously recommend it for the purposes stated above. It is represented at Fig. 8.

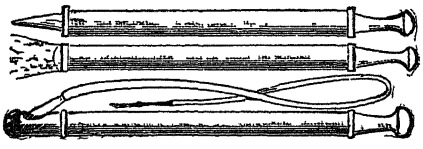

Fig 8. Lewis' Combination Pump.

New and improved styles of spraying machines are constantly being placed upon the market. One of the latest candidates for favor is represented at Fig. 9. It is manufactured by M. J. Caswell, Sandusky, Ohio, and is said, by reliable parties who have seen it in operation, to be thoroughly well made. It is designed for using both insecticides and fungicides in the orchard and vineyard.

A knapsack sprayer that seems to combine several good features has lately been put upon the market by the Field Force Pump Co., of Lockport, New York.

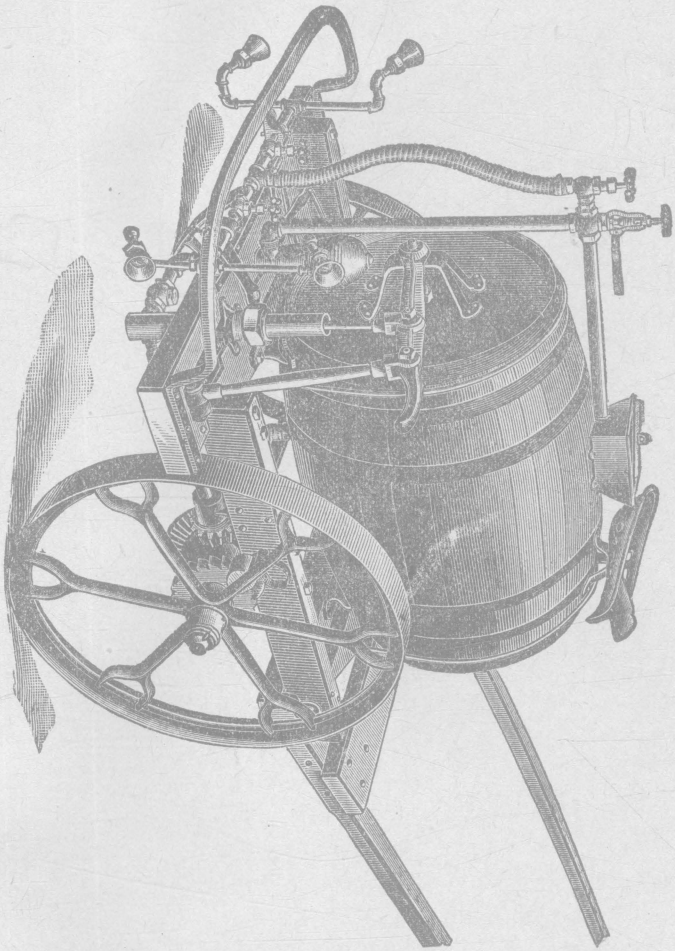

Fig. 9. M. J. C. Orchard and Vineyard Sprayer.

In addition to these, an effective line of machines which we have tried at the Station are manufactured by the Gould's Manufacturing Co., Seneca Falls, N. Y., and the Nixon Nozzle & Machine Co., Dayton, Ohio. Spraying machines which appear to be effective, although we have not had an opportunity of trying them, are also to be had of Wm. Stahl, Quincy, Illinois, and the Rumsey Manufacturing Co., Seneca Falls, New York.